Wide Area Recovery and Resiliency Program (WARRP)

Decon-13 Subject Matter Expert Meeting

August 14, 2012

The Commitment to Recover

The national commitment to recover, especially from terrorist incidents, may involve planning that is outside of normal processes and plans that are mostly response-centered

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14. ABSTRACT
The WARRP Decon-13 Subject Matter Expert (SME) Meeting, hosted by the U.S. Environmental Protection Agencys (EPAs) National Homeland Security Research Center (NHSRC), was held in Denver, Colorado, on August 14-15, 2012, at the Denver Animal Shelter (DAS). The purpose of the SME Meeting was to (1) identify existing technologies and methodologies that may help to minimize wastes, segregate waste streams, keep higher activity wastes separate from lower activity wastes, and, thereby, minimize cleanup and disposal costs, and (2) scope out what a draft standard operational guideline (SOG) might look like to assist in the cleanup and recovery of a wide-area RDD incident. This document contains the presentations made at the meeting.

15. SUBJECT TERMS
WARRP, Waste Management, Waste Screening

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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Complexities of Recovery

- Response is the first phase of recovery
  - Mitigation, Preparedness & Response are the first three steps in Recovery
  - Recovery must be started in the earliest days of Response
  - It is all about the economy….the is the **THE** outcome

WARRP Program Elements

Task	Effort	Capability Target & Objective
1	Front-End System Engineering Study and Gaps Analysis	Body of knowledge for national, state, and local restoration capabilities
2	Wide-Area Consequence Management Guidance and Frameworks	Develop guidance to address civilian & military needs and capabilities for recovery & restoration actions
3	Science and Technology Solutions	Recovery process methods, procedures, and technology development
4	Workshops, Exercises, and Demonstrations	Coordinate civilian & military community interoperability, and practical application of technology and concepts of operation
5	Transition to Use	Operationally relevant solutions to end-users


DRAFT

The Denver UASI
All-Hazards Regional Recovery Framework

DRAFT

Homeland Security

Current Status

- **Framework**
  - Writing Team Review Completed – July 17
  - Moving to final
- **Knowledge Enhancement Working Groups**
  - Behavioral Health – Aug 27
  - Unmet Needs & NGOs – Aug 30
- **Capstone**
  - Sept 13-14
  - Colorado Convention Center
  - Plenary Sessions
  - Workshops
  - Demonstrations of Science & Technology Research Projects

Science & Technology Projects

Focus	C/B/R	Project	WARRP Systems Study Gap [1,2]	Transition
Decon	R	Waste Screening & Segregation Methodologies	Gap 1.2	EPA
Sampling	B	Development of Automated Floor Sampling Device for *Bacillus anthracis* Spores	Gap 1.4	EPA
Decision Support	CBR	Early Abberation Reporting System (EARS)	Gap 2.4	CDC, DoD
Decon	B	Expanding Low-Technology Decontamination Options	Gap 1.5	EPA
Sampling	B	Systematic Evaluation of Aggressive Air Sampling for *Bacillus anthracis* Spores	Gap 1.4	EPA
Decision Support	CBR	Deployable Mapbook Composer	Gap 2.6	U.S. Secret Service
Decon	R	Demonstration of Cs-RDD Wash Aid	Gap 1.6	EPA, FEMA
Decision Support	B	Decontamination Strategy & Technology Selection Tool	Gaps 2.9, 3.5	EPA

[1]Gap definitions may be found in *WARRP Systems Study Report* (2011).
[2]For official report, contact WARRP Program Manager: christopher.e.russell@dhs.gov

Knowledge Enhancement Working Groups

- 30-31 Jan: CBR Workshop
- 15 Feb: Legal Authorities
- 21 Feb: Private Sector Economic Resiliency and Restoration
- 23 Feb: Multi-Agency Coordination Process
- 15-16 Mar: Waste Management Workshop
- 20 Mar: Private Sector Economic Resiliency & Restoration II
- 17 Apr: Damage Assessment
- 20 Apr: Building Abandonment
- 17 Jul Agriculture (FMD)
- 14-15 Aug: Decon-13 SME
- 27 Aug: Behavioral Health
- 30 Aug: Unmet Needs & Long-Term Recovery
- 13-14 Sep: Capstone

Local Commitment to Success

Local participants and stakeholder have contributed more than 10,000 hours of support to the success of the WARRP

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WARRP RDD Scenario – Radiological Waste Source, Generation, and Handling

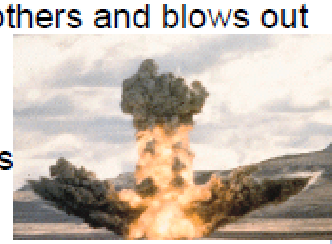
Bill Steuteville, Homeland Security Coordinator
U.S. Environmental Protection Agency Region 3

WARRP Radiological Waste Sampling Workshop
Denver, Colorado
August 14, 2012

Homeland Security
Science and Technology

WARRP RDD Scenario - Overview (Continued)

- Terrorists obtain approx. 2,300 curies of cesium-137 (CsCl) and 1.5 tons of ANFO and make 3000 pound truck bomb
- Terrorists detonate truck bomb containing the 2,300 curies of cesium outside the U.S. Mint in the downtown business district
- The explosion collapses the front of one building and causes severe damage to three others and blows out window of 5 other buildings
- Second explosion in Aurora a short time later outside Children's Hospital



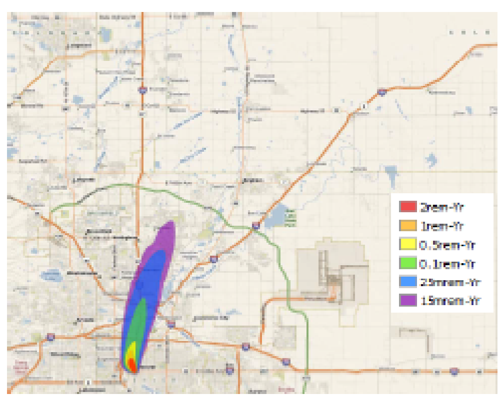
WARRP RDD Scenario - Overview

- Two Radiological Dispersal Device (RDD) attacks:
  - U.S. Mint (downtown Denver)
  - Anschutz Medical Campus (Aurora).
- Tens of thousands of people exposed, hundreds dead
  - Died of trauma from blast not radiation
- Evacuations/Displaced Persons
  - 10,000 evacuated to shelters in safe areas (decontamination required prior to entering shelters)
  - 25,000 in each city are given shelter-in-place instructions
  - Hundreds of thousands self-evacuate from major urban areas in anticipation of future attacks

WARRP RDD Scenario – Overview Downtown Release

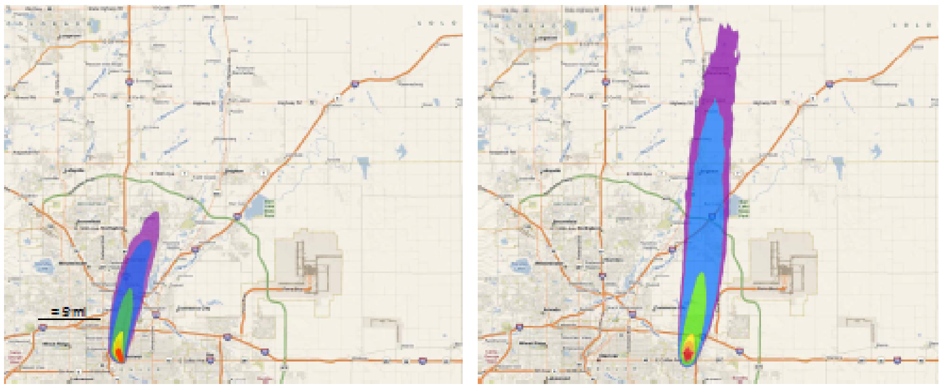
Most radioactive fallout is within tens of miles of blast, some may be carried up to hundreds of miles

- Hundreds of buildings contaminated
- Basic services affected
- Local businesses affected
- Government operations relocated
- Mass Transit (East-West rail line) affected
- Local military installations affected



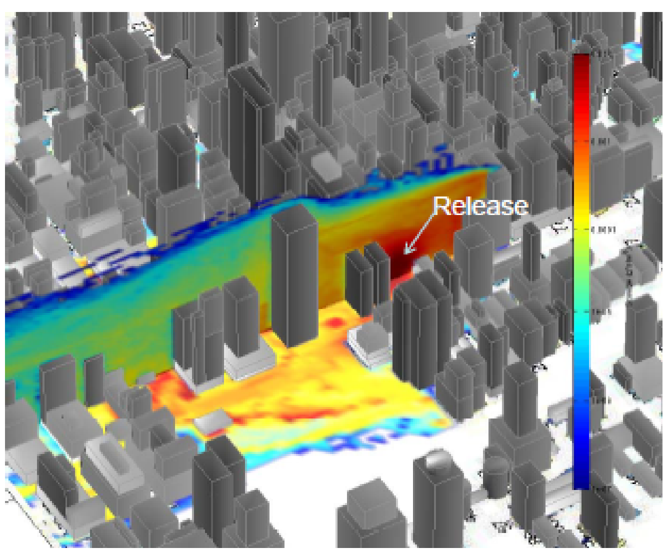
Twin Explosions; Two Plumes

Downtown: Tall buildings **Aurora: Flat terrain**



≈5 mi

WARRP RDD Scenario - Overview (Continued)



Airborne dose

Waste Estimation – Tools that were used

- RDD Waste Estimation Support Tool (WEST)
  - Building Stock and Outdoor Areas
  - Decon and Demolition Waste
- I-WASTE Tool
  - Building Contents
- Bio-response Operational Testing and Evaluation (BOTE) Program Personnel Decontamination Waste Generation Data
- Tested by Exercise Players at Liberty RadEx

Waste Classification

1. Class A Low Level Radioactive Waste (LLRW).
2. Class B/C LLRW (higher activity levels from blast zone or onsite concentration efforts)
3. LLRW with Asbestos (i.e., old steam pipes from demo buildings)
4. LLRW with PCB's (i.e., PCB transformer oils coating demolished building exteriors)
5. Low Level Mixed Waste (LLMW) (RCRA hazardous waste and low level radioactive waste)
6. Personal Protective Equipment (PPE) waste
7. Sludge from onsite decontamination efforts
8. Sludge from WWTPs
9. Laboratory samples
10. Contaminated clothing from off-site health facilities
11. Non-radiological solid or hazardous waste for disposal in RCRA C or D landfills

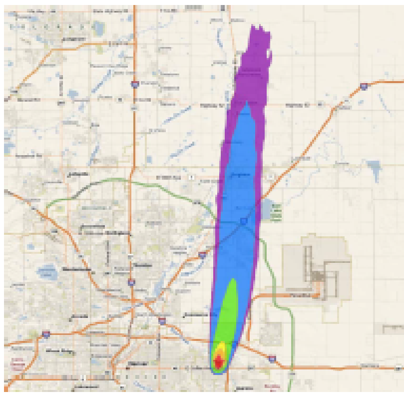
What Types of Radiological Waste Will be Generated?

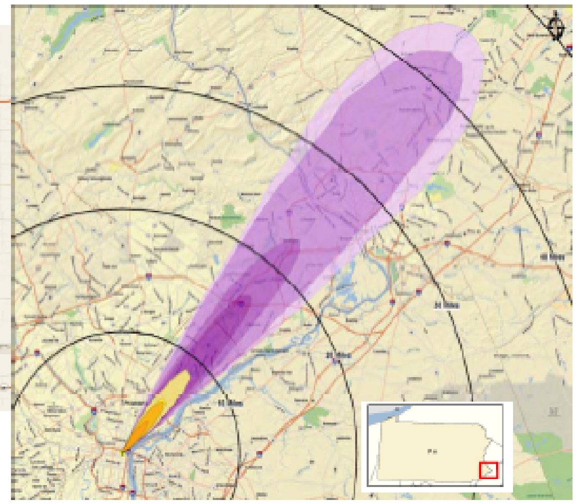
NRC Classification of Low Level Radioactive Waste (LLRW) as it relates to Cs-137:	
NRC Class	**% of Scenario Waste Volume**
Class A: 0-1 Ci/m^3	100% of liquid waste (1-3 billion gallons) >95% of solid waste (16-21 million tons)
Class B: 1 – 44 Ci/m^3	Minimal (<1% of solid waste)
Class C: 44 – 4600 Ci/m^3	Only in immediate blast zone Negligible (<1% of solid waste)

Translation into Number of Railcars/Dump Trucks

- Liquid Waste (Total ≈ 1.5 - 3 billion gallons)
  - 50,000 to 100,000 railroad tank cars (30,000 gallon capacity)
  - 275,000, to 550,000 tanker trucks (5,500 gallon capacity)
- Solid Waste (Total ≈ 16-21 million tons)
  - 160,000 to 210,000 Railroad hopper cars (100 ton capacity)
  - 400,000, to 525,000 semi-trailer (64,000 pound net capacity)
  - 500,000 to 656,000 tri-axel dump trucks
    - Put end to end 3700 miles long! (LA to NY to Atlanta and some…)

Liberty RadEx Exercise Comparison





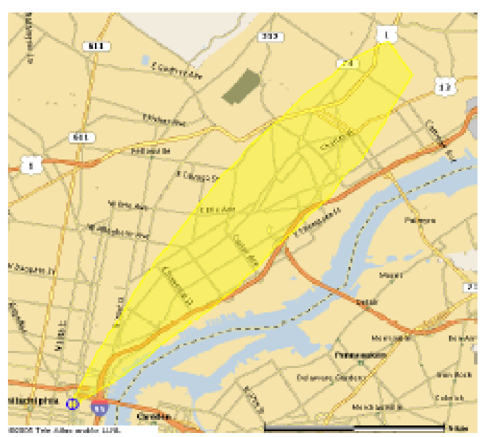
= 5 mi

Same scenario;
Single detonation;
Philadelphia, PA

LRE Relocation and Cleanup Areas

140,000 Temporarily Displaced

200,000 Must Have Property Cleaned



LRE – Cleanup Tactics and Technologies

Current Decontamination Technologies:

- Cleaning agents, acids, foams:
- Reduce radiation; do not eliminate radiation
- Most effective on non-porous surfaces or areas of marginal contamination and/or short-term exposures
- Quickly Clean and reopen CI/KR

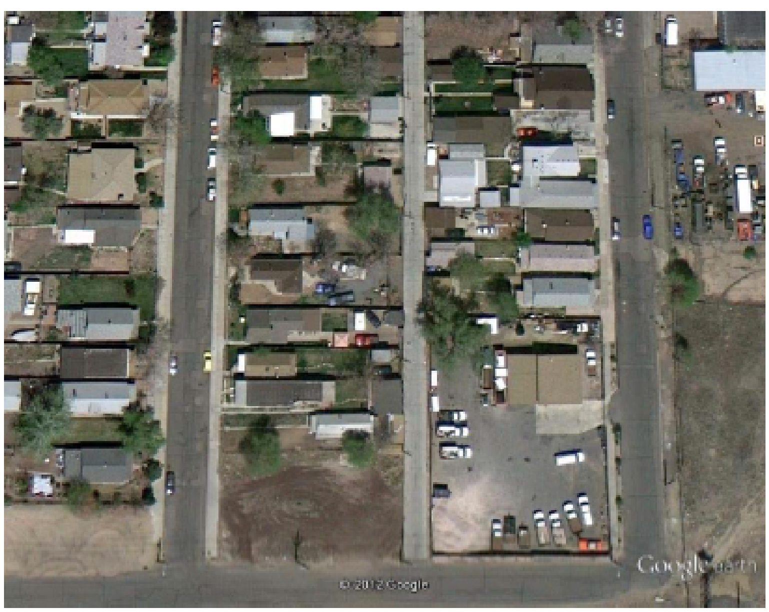
Most Effective Wide-Area Cleanup Strategies:

a) Roof Replacement
b) Soil Removal
c) Street and Sidewalk Surface Removal
d) Interior: dispose carpets, furnishings, possessions, drywall
e) Building demolition if higher contamination

Hiroshima

Hurricane Katrina

Typical Denver Street – Google Earth



Waste Consistency

- Except for immediate area of bomb (1 block radius), RDD wastes should be highly homogenous
  - Remove cars, swing sets, bird baths: anything not fixed
  - Remove trees & shrubs
  - Empty building contents
  - Remove tanks, drums, transformers, other hazardous waste
  - Remove roof & siding (option if building is being saved)
  - Demolish & remove buildings
  - Excavate soils

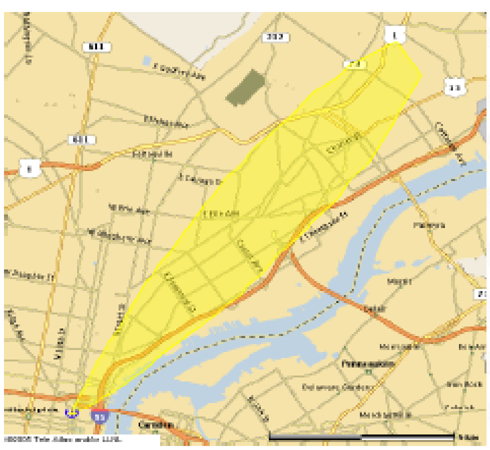
    Remove or scarify concrete & asphalt
- This generates uniform homogenous waste streams
- This how EPA cleans Superfund sites
- Makes waste characterization & disposal easier

LRE – Cleanup Tactics and Technologies

Cleanup, Waste, Waste Handling, Disposal & Costs

- Day One: Begin generating solid and liquid wastes
  Responder, public, & hospital PPE & decon
- First Week: Begin generating significant liquid and solid wastes with CI/KR decontamination activities
  - Temporary storage locations
- First Month: Begin generating huge volumes of liquid and solid wastes with initial cleanup operations
  - Soils, demolition wastes, furnishings, office materials, etc.
  - Roofing materials, asphalt & concrete scarification
  - Need long-term storage locations and/or permanent disposal
- Cleanup can not proceed without waste handling options
- Cleanup will be prohibitively costly and snail-pace slow without local waste solutions

LRE Citizen Stakeholder Panel: Cleanup prioritization & Waste storage



Philadelphia citizens had no difficulty with concepts of cleanup prioritization, local storage and disposal, and difficult choices

State Leadership: Cleanup Criteria, Waste Disposal, Community Involvement

- Pennsylvania Department of Environmental Protection
  - Bureau of Radiation Protection
  - Led by David Allard, Director Radiation Programs
- Evacuation recommendations, cleanup criteria, waste storage and disposal decisions
- Leading Technical Advisory Panel
- Working with Community Advisory Panel
- Radiation Expertise and Leadership

Waste Management Organizational Structure

Eugene Jablonowski
U.S. EPA Region 5 Emergency Response

U.S. Environmental Protection Agency and
U.S. Department of Homeland Security
WARRP Decon-13 Subject Matter Expert Meeting
Waste Screening and Waste Minimization Methodologies Project
August 14 – 15, 2012
Denver, Colorado

Incident Command System
ICS Overview

ICS is a standardized, on-scene, all-hazards incident management approach that:

- Allows for the integration of facilities, equipment, personnel, procedures, and communications, to operate within a common organizational structure.
- Enables a coordinated response among various jurisdictions and agencies, public and private.
- Establishes common processes for planning and managing resources.

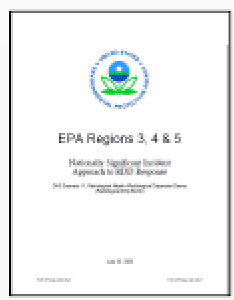
ICS is flexible and can be used for incidents of any type, scope and complexity.

Incident Command System
ICS Overview

- ICS allows its users to adopt an integrated organizational structure to match the complexities and demands of single or multiple incidents.
- ICS is typically structured to facilitate activities in five major functional areas: Command, Operations, Planning, Logistics, and Finance/Administration.
- Intelligence/Investigations is an optional sixth functional area.
- Federal, State and local agencies are represented in the IC/UC in accordance with NIMS principles regarding: jurisdictional authorities, functional responsibilities, and resources provided.

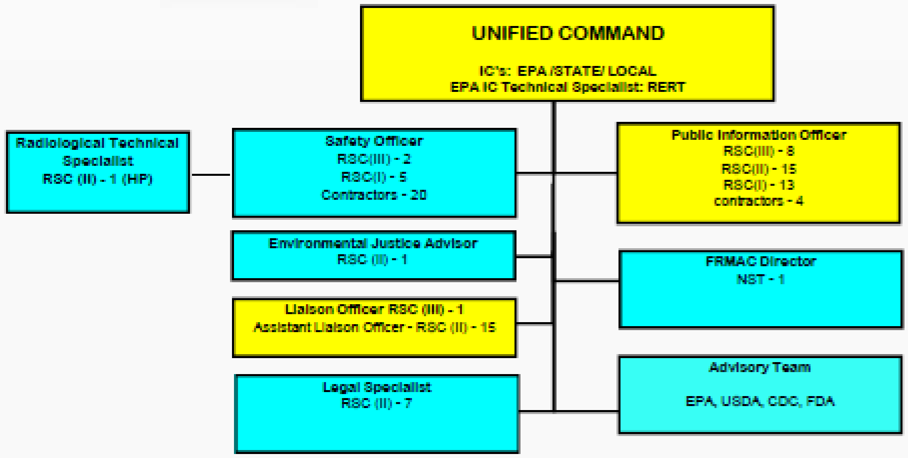
Region 3,4,5 Plan
Approach to RDD Response

- EPA Regions 3, 4 & 5 developed an approach to RDD response
- Part of a national planning exercise to meet national homeland security goals.
- ID-ed necessary EPA resources, resource "gaps," and other issues requiring further development, both regionally and nationally.
- Improves EPA's preparedness to respond to a RDD event and multiple "incidences of national significance."
- Approach exercised at "Liberty Rad-Ex."



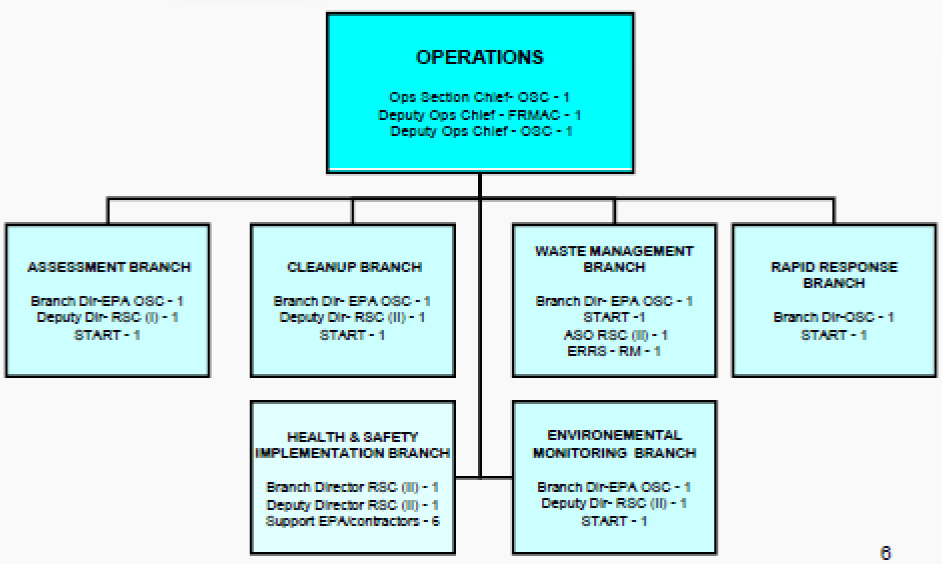
EPA Regions 3, 4 & 5

Region 3,4,5 RDD Approach
Command

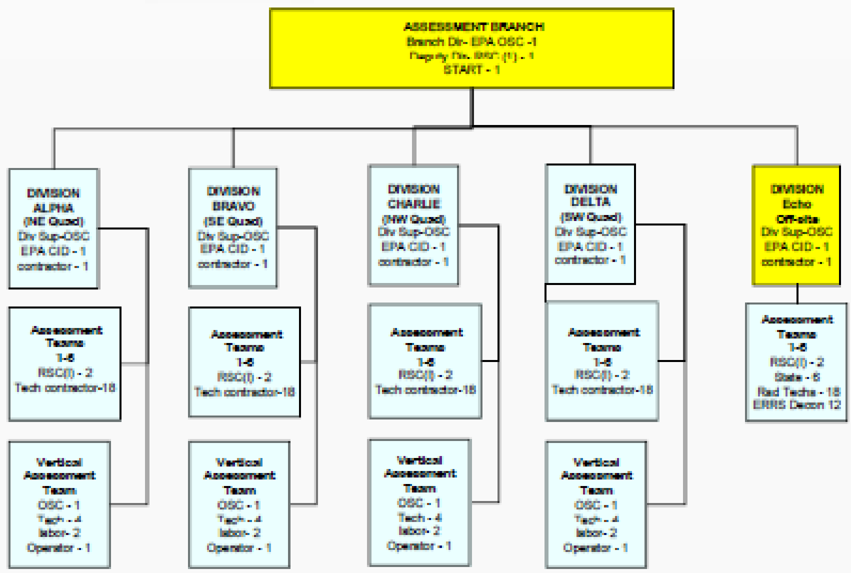


Yellow boxes = anticipated areas of State and Local personnel to assist in staffing

Region 3,4,5 RDD Approach
Operations



Region 3,4,5 RDD Approach
Operations



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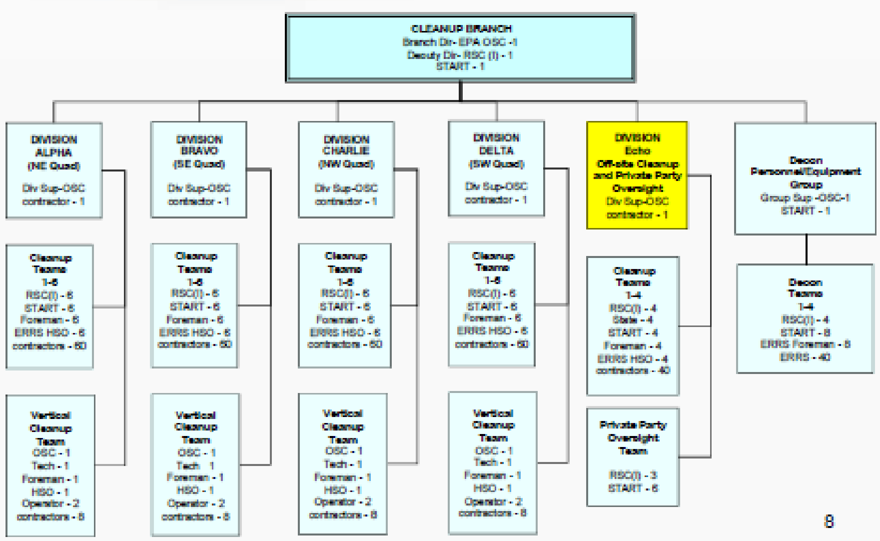
Region 3,4,5 RDD Approach
Operations



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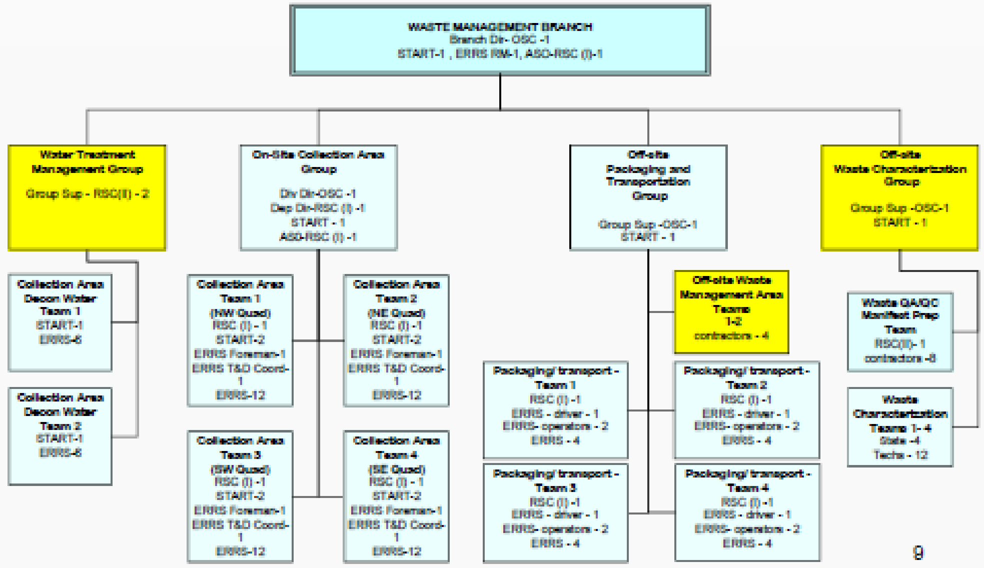
Region 3,4,5 RDD Approach
Operations



Region 3,4,5 RDD Approach
Waste Management Branch

- The Waste Management Branch is responsible for collection, storage, characterization, documentation, shipping, and/or treatment of all wastes generated or collected on-site during ESF-10 activities including:
  - radiological waste,
  - solid wastes,
  - liquid wastes, and
  - other hazardous materials and non-hazardous wastes generated by field activities.

Region 3,4,5 RDD Approach
Waste Management Branch

The Waste Management Branch includes four groups:

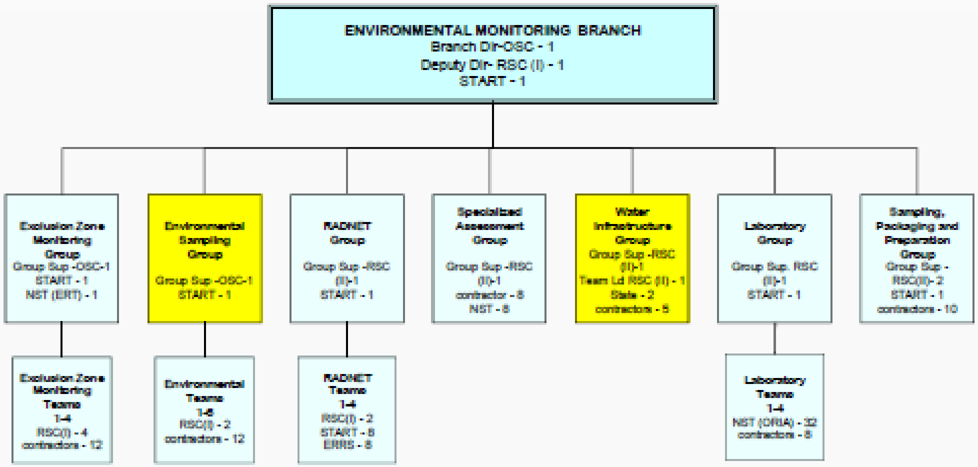
1. *Waste Water Treatment and Handling Team* is responsible for storing, treating and shipping waste water, including personnel decon water, collected during field response activities.
2. *On-site Collection Team* is responsible for collecting wastes from cleanup operations, and transporting the wastes to on-site collection areas where it is grossly characterized and containerized for storage.

Region 3,4,5 RDD Approach
Waste Management Branch

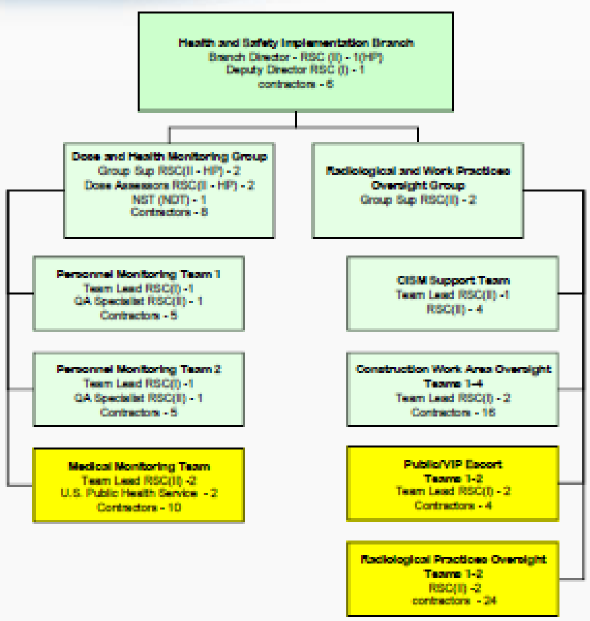
Waste Management Branch *(continued)*…

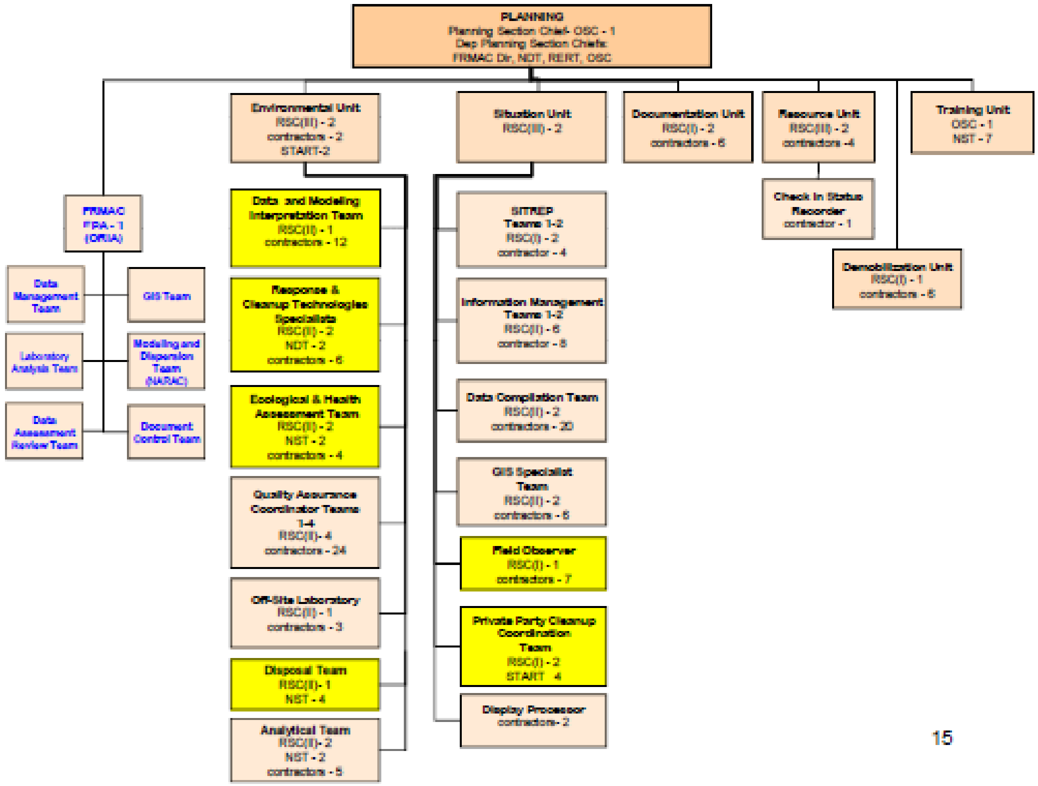
3. *Near-site Packaging and Transportation Team* is responsible for collecting wastes from the on-site collection areas transporting it to the central storage area, where the wastes are characterized and packaged for off-site transportation, manifested and shipped for final off-site treatment and/or disposal.
4. *Off-Site Characterization Team* is responsible for characterization and manifesting the wastes for off-site treatment and final disposal.

Region 3,4,5 RDD Approach
Operations



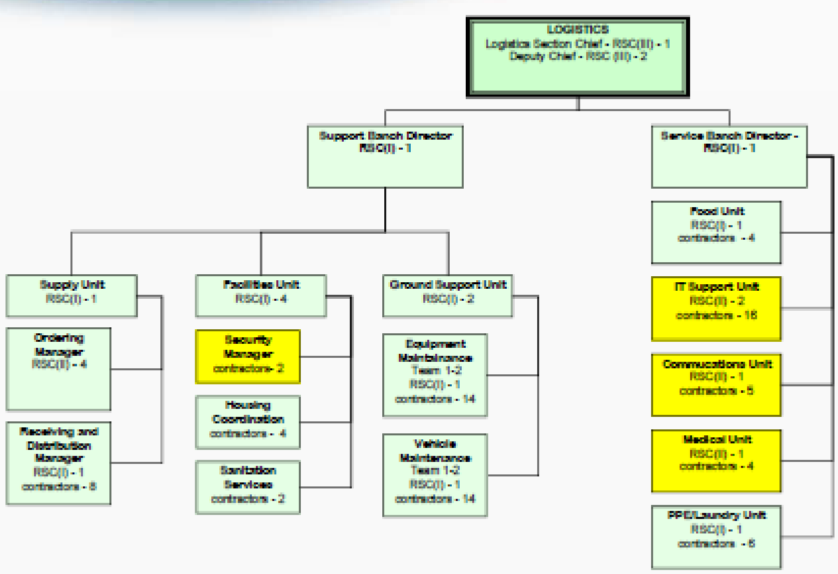
Region 3,4,5 RDD Approach
Operations





Region 3,4,5 RDD Approach

Logistics



Region 3,4,5 RDD Approach
Waste Management Tactics

- Waste management tactics during the early phase will consist of supporting first responders by removing debris to support the life saving missions.
- Removal of this debris will be critical for dose control.
- Quick identification of interim sites to temporarily store contaminated waste and debris may be necessary.
- Early identification/determination of disposal facilities.
- Determining and establishing waste acceptance criteria (WAC) for disposal facilities.
- Facility-specific WAC info would be used to plan for waste sampling/characterization, packaging, transportation, etc.

Region 3,4,5 RDD Approach
Potential Disposal Options

- All options would need to be addressed with the impacted state and the receiving states, if different.
- Balanced approach to waste disposal:
  - Smaller volumes of higher activity waste are disposed at a federal disposal site, or one of the commercial licensed/permitted disposal facilities.
  - Larger volumes of lower activity waste are managed at a RCRA Subtitle C facility near the site, or at an incident-specific Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA") disposal facility that would meet the design criteria of RCRA Subtitle C and NRC 10 CFR 61.

Region 3,4,5 RDD Approach
Potential Disposal Options

- Recognition that some sort of hazardous and mixed waste management may be needed depending on the incident location and impacted buildings/areas (e.g., radiation- contaminated asbestos containing material (ACM) for example).
- Characterization is performed on a bulk ISO-container level or through waste stream knowledge, where uncertainties are compensated by disposal facility design.
- Allowances are made for temporary storage near the site or off-site while permanent disposal capacity is being prepared.

Region 3,4,5 RDD Approach
Other Issues

- Waste Packaging. Procedures need to be developed specifying how wastes will be packaged, acceptable types of packaging, segregation of prohibited items, and documentation required to demonstrate traceability of waste from the point of generation through package certification.
- Waste Certification. (DOE Disposal Only) Procedures will be required specifying roles, responsibilities, and controls in place to ensure that radioactive waste is generated, packaged, characterized, and certified in a manner that preserves the requirements for off-site DOE disposal.

Region 3,4,5 RDD Approach

Questions?

RDD Case Studies
Japan, Chernobyl, Goiania

Waste Screening Workshop
August 14, 2012

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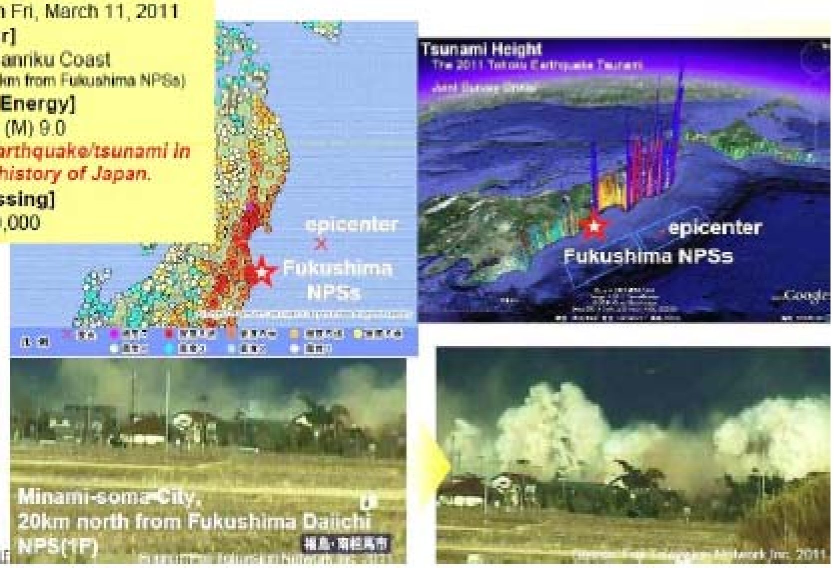
Homeland Security
Science and Technology

Wide Area Recovery & Resiliency Program
Denver Area UASI

Japan: Scenario

[Date/Time]
2:46 pm on Fri, March 11, 2011
[Epicenter]
Offshore Sanriku Coast
(approx. 180 km from Fukushima NPSs)
[Seismic Energy]
Magnitude (M) 9.0
Largest earthquake/tsunami in recorded history of Japan.
[Dead/Missing]
Approx. 20,000



Japan: Impact of Earthquake and Tsunami Damage to the Reactors

Level 7 – "Major Accident" on International Nuclear Event Scale

- "A major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures"

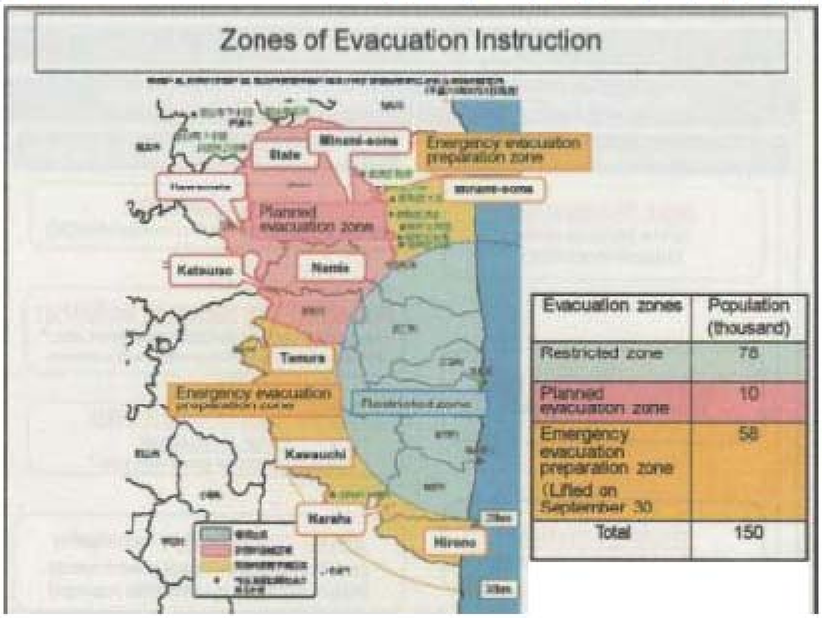
- Loss of Cooling
- Damage to Secondary Containment Vessels
- Fuel Meltdown (partial or complete – three of six units)
- Hydrogen Explosions units 1, 2 and 4.

Radionuclide Releases - Evacuation

- Early evacuation decisions driven by release and deposition of
  - Iodine-131 (8-day half-life)
  - Cesium-134 (2-year half-life)
  - Cesium-137 (30-year half-life)

- Evacuation out to 20 km, restricted entry to 30 km
  - >150,000 people evacuated, ~100,000 still displaced, many will not be able to return for years
  - Zones extended beyond 20 km in highly affected areas to northwest

Evacuation Zones (20 km + >20 mSv/y



Evacuation zones	Population (thousand)
Restricted zone	78
Planned evacuation zone	10
Emergency evacuation preparation zone (Lifted on September 30	58
Total	150

Radionuclide Releases - Cleanup

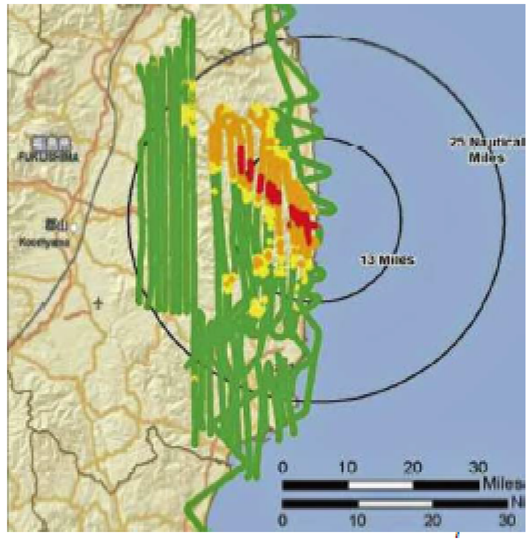
- Two radionuclides are driving long-term cleanup
  Cesium-137 (30-year half-life)
  - Cesium-134 (2-year half-life)

- Some reports of Strontium-90 (29-year half-life) and Plutonium outside boundaries of nuclear plants
  - Tiny quantities
  - Few locations

- [Note: Iodine-131 (8-day half-life)]
  - Driver for initial protective actions
  - not a concern in the long term (short half life, decayed away)

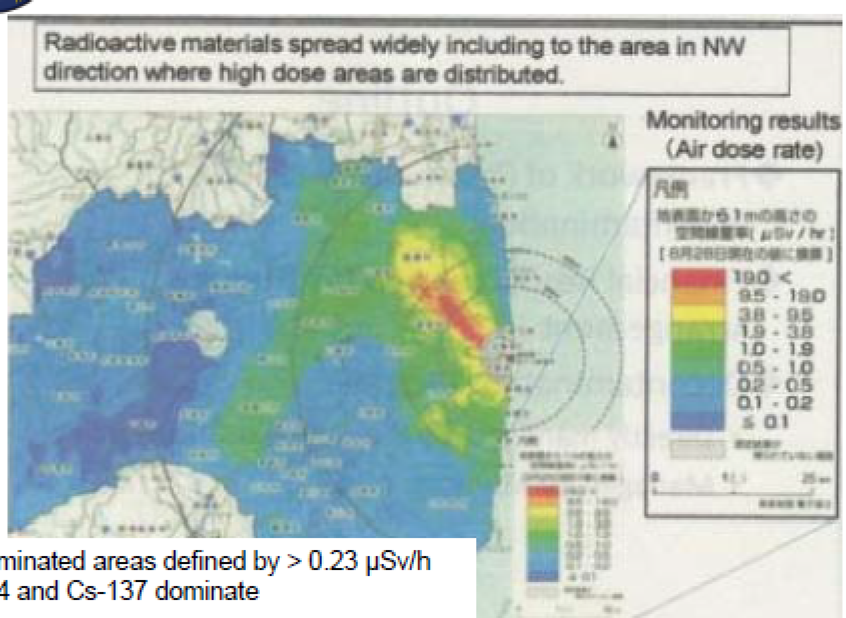
Japan: Impact of Earthquake and Tsunami: Releases of Radiation to the Environment

- Air Releases – intentional venting, containment breach & hydrogen explosions
  - ~150 PBq of ^{131}I
  - ~10 PBq of ^{137}Cs
- Ocean Releases – intentional release of cooling water & leakage
- ^{131}I equivalent activity release of ~500 PBq,
- Total release ~10% - 20% of releases from Chernobyl



(37 PBq = 1,000,000 Curies)

Wide Area Contamination MEXT data as of September 15, 2011



Contaminated areas defined by > 0.23 μSv/h
Cs-134 and Cs-137 dominate

Japan: Description of Waste Streams

- Management of radioactive waste significantly complicated by aftermath of earthquake and tsunami
  - Buildings destroyed
  - Infrastructure damaged
  - Agricultural areas flooded and contaminated
  - Mixtures of toxic and hazardous substances widespread
  - Accumulation of wastes from treating power plant effluents
  - Significant ocean releases could lead to re-contamination
  - "Hot spots" found across the country
  - Might be considered comparable to nuclear device damage
- Japan relies heavily on incineration of solid waste
  - Precautions to avoid re-suspension of radioactive material
  - Concentration of radioactive material in ash

Japan – Path to Restoration and Recovery

- Government of Japan has spoken of adopting international reference levels of 1 to 20 mSv per year (100 mrem to 2 rem/yr) as a benchmark for restoration
  - Prioritize cleanup of areas up to 50 mSv/yr (5 rem/yr) to allow return of residents by March 2014 (>5 rem/yr may be deferred)
    - Schools and other child-sensitive areas
    - Agricultural production areas
      - Restrictions on planting in highly-contaminated areas
      - Research on effects on different plant types
  - Iterative process to reach 100 mrem/yr or lower will take years
    - Localities responsible for areas <100 mrem/yr
  - 70,000 square meters of seabed to be covered (cement & clay)
  - Next slide shows extent of contamination and significant areas above 20 mSv per year (bright green and above)

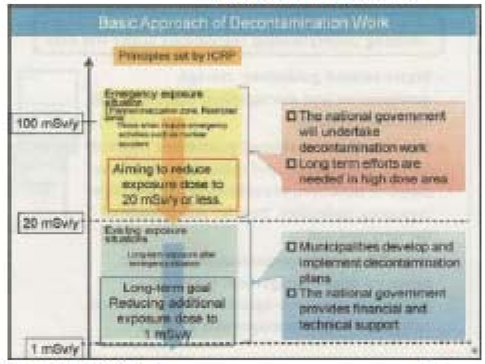
Special Decon Areas	Intsv. Cont. Sur. Areas
> 20 mSv/y	1 to 20 mSv/y
11 municipalities	104 municipalities
Led by MOEJ	Led by Prefecture

Dose are above nat'l background + medical

Current Goals:

General Public 50% reduction by 08/13

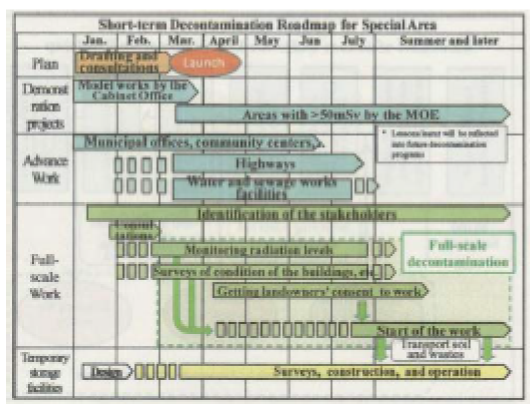
Children 60% reduction by additional decon of living environment.



Source: OHMURA presentation, May 19, 2012

Decon Roadmap for Special Decon Areas (20 km + > 20 mSv/y)

- Plan developed by March 2012
- Advance decon work for public facilities (city and town halls) and infrastructures (highway, water facilities)
- Priority given to > 20 mSv/y and 20 to 50 mSv/y with an aim of returning evacuees.
- > 50 mSv/y used for Decon projects
- Policy : focus on areas with highest exposures first

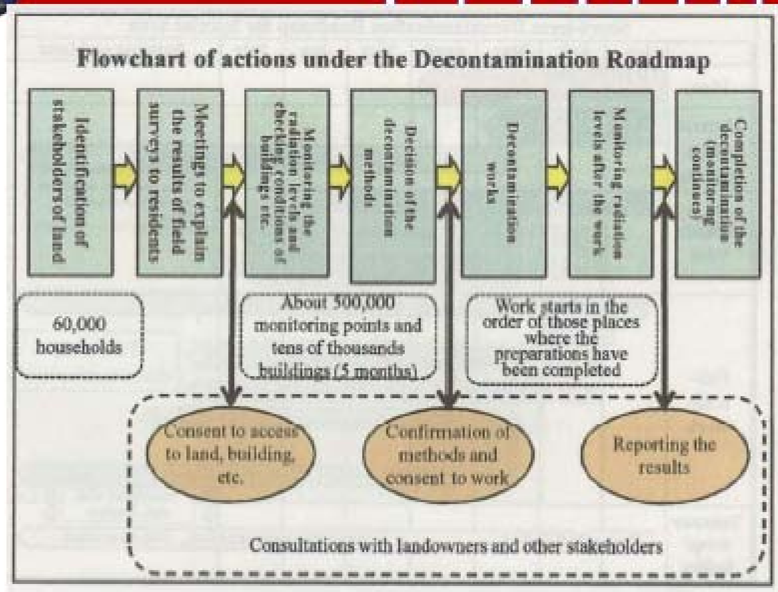


Source: OHMURA presentation, May 19, 2012

Special Decon Areas (>20 mSv/y)

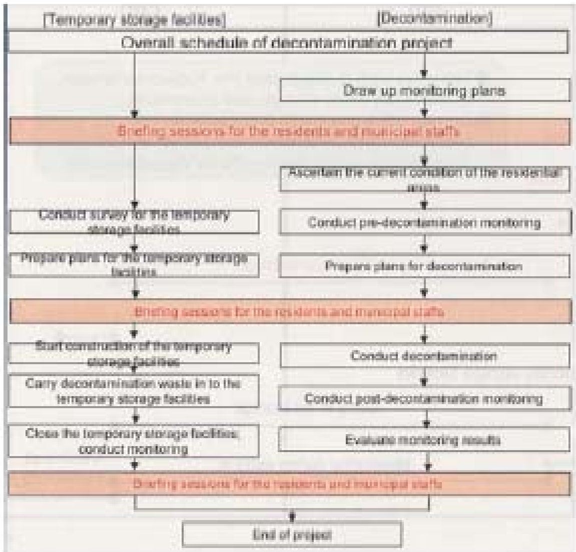
- 25 Proposals - Impacting
  - 221 ha (≈550 acres)
  - 12 municipalities
- Decon Projects
  - Farmland
  - Roads
  - Woodlands / forest
  - Structures
    - schools
    - railroad stations
    - libraries
    - playgrounds
    - factories
    - houses

Source: ISHIDA presentation materials, JAEA



Source: OHMURA presentation, May 19, 2012

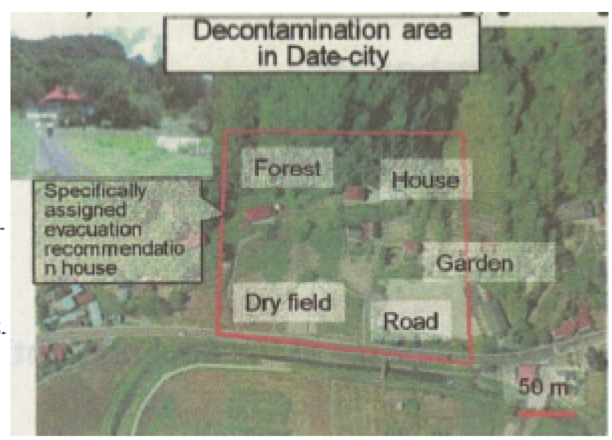
Decontamination Case-Study Model



- Work Categories
  1. Decon
  2. Temporary Waste Storage
  3. Monitoring
- **Timelines**
  - 1 month for Prep (includes stakeholder input)
  - 1 to 2 months for Decontamination

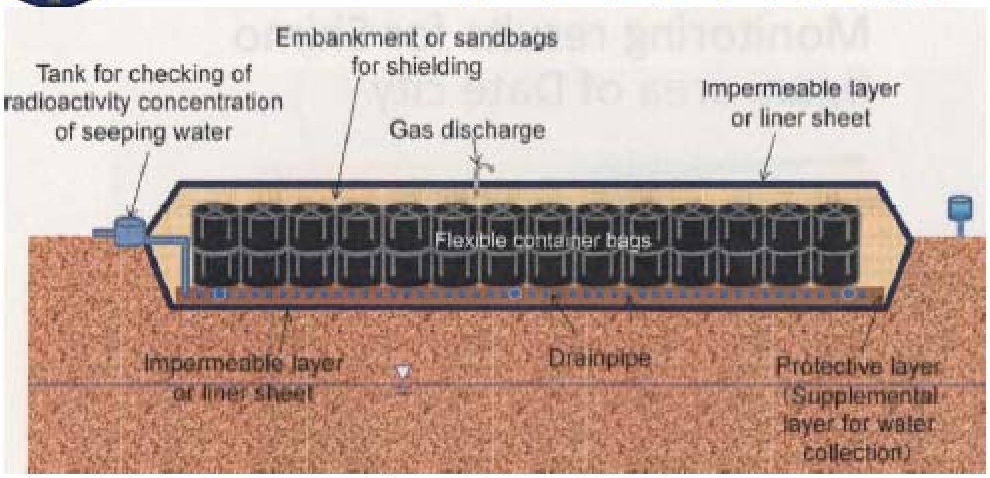
Decontamination Projects Date and Minami-soma Cities

- Houses
  - •High Pressure Spray
  - •Brushing, etc.
- •Gardens
  - •High pressure spray
  - •Mowing
  - •Removal of top soil, etc.
- •Rice Fields, dry fields
  - •Removal of top soil
  - •Poly-ion absorption, etc.
- •Forest
  - •Collecting fallen leaves
  - •Pruning
  - •Removal of topsoil
- •Roadside ditch
  - •Brushing
  - •Grinding, etc.



Source: OHMURA presentation, May 19, 2012

Temporary Radioactive Waste Storage



Local interim storage capacity sought to facilitate cleanup

Facility to be capable of storing ~280 million tons by 2015

Resistance from local communities/officials

Want assurance that facilities will not be permanent

Japan: Waste Management Issues and Lessons Learned

- Early estimates from Government of Japan
  - ~30 million tons of soil to be removed in Fukushima Prefecture
  - ~13% of land area in the prefecture
    - Estimated to reach cleanup level of 5 mSv/yr
  - ~11,000 square kilometers nationally contaminated >1 mSv/yr
    - 3% of land area in Japan
  - Storage capacity sought for ~90 million cubic meters of soil
    - ~3 billion cubic feet
    - ~20% of volume landfilled annually in US
  - Incinerator ash up to 8 Bq/g (216 pCi/g) allowed to be landfilled
- Local interim storage capacity sought to facilitate cleanup
  - Facility to be capable of storing ~280 million tons by 2015
  - Resistance from local communities/officials
  - Want assurance that facilities will not be permanent

Japan – Additional Considerations

- Restrictions on distribution of Fukushima products
  Meat, milk, rice, fish, other
  - Fund of >40 billion yen (~$500 million) to restore confidence
  - Building materials (e.g., lumber, stone, aggregate)
    - One quarry found highly contaminated
- Atypical waste streams/vectors
  - Leaves from forested areas piling up (incineration concerns)
  - Wastewater treatment sludge and ash accumulating at facilities
  - River transport of contaminated sediments
  - Local citizens (not trained workers) doing cleanup/ad hoc disposal
- Uncertain future of contaminated areas
  - Power plants likely to be left in place for some period
  - Youngest evacuees considered least likely to return

Japan – Some Headlines

Mixed Reaction Over Plan for Fukushima County to Store Radioactive Waste (Mainichi Daily News, March 12, 2012)

Three Towns Near Fukushima No. 1 Asked to Store Radioactive Soil, Waste (Japan Times, March 11, 2012)

Disposal Sites Refuse to Accept 140,000 Tons of Tainted Waste (Yomiuri Shinbun, March 4, 2012)

86% of Municipalities Reluctant to Accept Debris from March Disasters (Mainichi Daily News, March 4, 2012)

6,800 Tons of Radiation-Tainted Straw Left Lying in 8 Prefectures (Mainichi Daily News, March 3, 2012)

Radiation Fears Behind Debris Refusal (Yomiuri Shinbun, November 4, 2011)

No-Go Zone Soil To Be Moved in 2-1/2 Years (Yomiuri Shinbun, October 12, 2011)

Japan – Implications for RDD Waste

- While the scale of the Fukushima accident likely exceeds the impacts from an RDD, several aspects are relevant:
  - Cleanup goals will affect the volumes of waste generated
  - Decontamination strategies will also affect waste volumes
  - Likely to be public pressure to accelerate cleanup
    - Desire to return to affected area to live or work
    - Prioritizing certain areas/functions (e.g., schools)
  - Federal, state, and local roles and responsibilities for decision-making on cleanup and waste management may create tension
    - Local management of waste will be expected
  - Initial focus on waste staging, temporary and longer-term interim storage – disposal likely will take more time

Chernobyl - Scenario

- On April 26, 1986, Unit 4 of the Chernobyl Nuclear Power Plant suffered catastrophic failure (Level 7 on the International Nuclear Event Scale)
  - Explosion and fire breached containment and spread radioactivity into the atmosphere and around the world
    - Estimated releases up to 8 EBq (8×10^{18} Bq) (excluding noble gases)
  - Fuel meltdown
  - Several dozen emergency "liquidators" working to put out the fire died from the effects of radiation

Chernobyl – Contamination (1 of 2)

- Several zones defined for "contaminated areas" (those exceeding 1 Curie per square kilometer of Cs-137)

^{137}Cs soil deposition	Designation in Belarus	Designation in Russian Federation	Designation in Ukraine	Designation in this report
37–185 kBq/m^2 (1–5 Ci/km^2)	Periodic control	Favourable social and economic status	Reinforced radiological control	**Radiological control**
185–555 kBq/m^2 (5–15 Ci/km^2)	Right to be resettled	Right of relocation	Guaranteed voluntary resettlement	**Voluntary resettlement**
555–1480 kBq/m^2 (15–40 Ci/km^2)	Subsequent resettlement	Relocation	Obligatory resettlement	**Obligatory (subsequent) resettlement**
> 1480 kBq/m^2 (> 40 Ci/km^2)	Immediate resettlement	Obligatory relocation	Obligatory resettlement	**Obligatory (immediate) resettlement**

Source: IAEA Tecdoc 1240, 2001

Chernobyl – Contamination (2 of 2)

- Exclusion Zone
  - 2040 km² Ukraine
  - 2100 km² Belarus
  - 170 km² Russia
  - ~4300 km² total
- Contaminated area (>1 Ci/km² of Cs-137) totals ~140,000 km²
- ~8,000 km² of agricultural land, ~7,000 km² of timber land out of production

Chernobyl – Impacts on Population

- As of 2000, ~350,000 people had been resettled
  - ~4.5 million living in contaminated areas
  - Initial annual dose target of 500 mrem/yr, later changed to 100
  - Estimated costs of 100s of billions in U.S. dollars

Table 3.2. Average individual doses received 1986-1995 by population of affected territories in relation to current density of contamination by ^{137}Cs

Land contamination by ^{137}Cs, Ci/km²	Average individual doses* received in 1986-95 by residents of affected territories, mSv		
	Belarus	Russia	Ukraine
1-5	3.9	4.2	11.7
5-15	18.7	13.0	24.4
> 15	47.0	35.7	82.6

Source: derived from UNSCEAR 2000. *Note:* * - excluding doses to thyroid

Table shows cumulative doses. 1 mSv = 100 mrem

Chernobyl – Waste Management

- Limited effort to decontaminate except to support reactor decommissioning (even in populated areas)
  - >1 million m³ of waste generated from rubble, debris, soil
  - Trees bulldozed and buried
  - ~800 burial areas in Ukraine exclusion zone, largely without characterization or segregation
    - "These facilities were established without proper design documentation and engineered barriers and do not meet contemporary waste disposal safety requirements" - Chernobyl Forum
    - *Vector* site to provide upgraded treatment, sorting, packaging, and disposal capabilities for long- and short-lived waste
  - Reactor shelter (sarcophagus) also being upgraded
  - Belarus reviewing disposal areas for potential upgrades

Gioania - Scenario

- On September 13, 1987, an abandoned teletherapy source was removed for sale as scrap metal
  - 1,375 Curies of Cs-137
- The source was breached and resulted in contamination of people and property
  - Four deaths, 28 radiation burns, multiple others exposed
  - Radiation measured at 0.4 Sv/h (40 rem/h) at 1 meter

Gioania - Impacts

- Authorities moved quickly to contain the incident
  85 houses found to be contaminated, 41 evacuated
  - 45 public places found to be contaminated
  - Demolished seven residences and numerous other buildings
  - Topsoil removed from large areas
  - Total waste generated ~3,500 m^3 – about 150,00 times the volume of the original source
  - The source was placed in a sack on a chair, which was then encased in concrete and packed in a special container
- Authorities screened many people who were not exposed
  - 112,000 people monitored, 249 found with some contamination
  - Widespread fear and stigma associated with the incident

Goiania – Waste Categorization

- Waste from the incident was categorized and segregated for disposal (time for Cs-137 to reach 87 Bq/g)

Table D.6. Waste from Goiânia Accident

GROUP (Time - years)	Number Metallic Boxes	Volume (m^3)	Number of Drums	Volume (m^3)	Storage Activity * (TBq)	Total Volume (m^3)	Current Activity (TBq)
I (t=0)	404	686.8	2710	542	0,06	1228,80	0,03
II (0 < t < 90)	356	605.2	980	196	0,476	801,20	0,250
III (90 < t < 150)	287	487.9	314	62.8	1,44	550,70	0,76
IV (150< t <300)	275	467.5	217	43.4	13,67	510,90	7,19
V (t > 300)	25	42.5	2	0.4	30	42,90	15,80
Total	1347	2289.9	4223	844.6	45,71	3134,50	24,03

*NOTE: * Storage Activity: at the time of storage / ** Current Activity: as of March 2008.*

Source: National Report of Brazil for the Third Review Cycle of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

Goiania – Waste Management

- Two near-surface repositories were constructed ~23 km from Goiania, near the temporary storage site
  - Great Capacity Container for Group I (short-lived) waste
    - About 40% of the total volume
    - Group I waste could have been released as solid waste
  - Goiania Repository for Groups II – V
    - More extensive engineered barriers
  - Site selected after extensive study
    - 189 "preliminary areas" identified
    - Narrowed to 18 "potential areas"
    - 3 candidate sites selected for final decision
  - Repositories opened in 1995

Goiania – Waste Disposal Sites

Figure D.4. Great Capacity Container

Figure D.5. Repository at Abadia de Goiás

Thank you

Questions?

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Homeland Security
Science and Technology

Wide Area Recovery & Resiliency Program (WARRP)

Pete Van Voris, Ph.D.
Consultant & Advisor to WAARP

Chemical and Biological Defense Division
Science and Technology Directorate
DEPARTMENT OF HOMELAND SECURITY

Homeland Security
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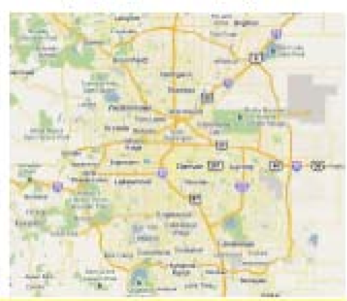
Wide Area Recovery and Resiliency Program

Goal:
Working with interagency partners, including federal /state / local / tribal governments, military, private industry and non-profit organizations, develop solutions to reduce the time and resources required to recover wide urban areas, military installations, and other critical infrastructures following a catastrophic chemical, biological, or radiological (CBR) incident.

Objectives:

1. Develop/refine guidance, plans, and decision frameworks for long term recovery that can be leveraged and transitioned to other parts of the United States and internationally as applicable.
2. Identify, develop/refine, demonstrate, and transition technologies/standards that support recovery prioritization, planning and operations.
3. Better understand the public health strategies and challenges related to long term recovery and recommend changes as needed to public health guidance and/or plans.
4. Exercise programmatic solutions for CBR recovery
5. Enhance long-term formal coordination between DOD, DHS, DOE, EPA, and HHS that will be optimized for stakeholder use at the state, regional, and local levels.

DHS (S&T) sponsored program



Coordination & partnership with the Denver, CO region

WARRP Problem Statement

- Collaborative program with the Denver Urban Area Security Initiative (UASI) and State of Colorado
  - **Goal:** Develop solutions to reduce the time and resources required to recover wide urban areas, military installations, and other critical infrastructures following a catastrophic chemical, biological, or radiological (CBR) incident.
  - **Stakeholders:** Interagency partners, including federal /state / local / tribal governments, military, private industry and non-profit organizations
- WARRP – Resiliency through Partnership
  - **Program Alignment:**
    - National Security Strategy goal to "strengthen security and resilience at home" against the all hazards threat (May 2010)
    - FEMA 2011-2014 Strategic Plan to build the Nation's capacity to stabilize and recover from a catastrophic event through "Whole Community" approach
  - **S&T Development:**
    - Enhanced capabilities for wide area urban recovery from a large-scale CBR incident
    - Solutions aligned with Interagency validated gaps list
    - Capability Areas: Characterization, Remediation, Clearance, Public Health

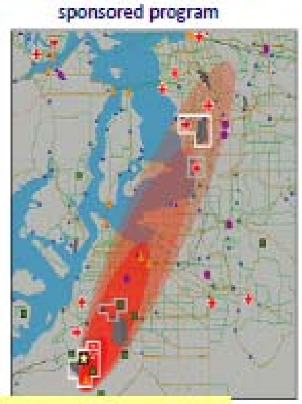
Interagency Biological Restoration Demonstration

DOD (DTRA) & DHS (S&T) co-sponsored program

Goal: Working with interagency partners, including state, regional & local, to reduce time and resources required to recover and restore wide urban areas, military installations, and other critical infrastructures following a biological incident

Objectives:

- Study social, economic & operational interdependencies
- Establish civilian and military coordination
- Develop guidance and decision frameworks
- Identify & demonstrate technologies that support operations
- Exercise activities & available technology solutions



Coordination & partnership with the Seattle, WA region

Homeland Security
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Response and Recovery Actions (BW)

As defined by the Office of Science and Technology Policy (OSTP)

RESPONSE AND RECOVERY ACTIVITIES					
(CRISIS MANAGEMENT)		(CONSEQUENCE MANAGEMENT)			
Notification	First Response	Remediation/Cleanup			Restoration (Recovery)
		Characterization	Decontamination	Clearance	
Receive information on biological incident Identification of suspect release sites Notification of appropriate agencies	Initial threat assessment HAZMAT and emergency actions Forensic investigation Public health actions Screening sampling Determination of agent type, concentration, and viability Risk communication	characterization of biological agent Characterization of affected site Site containment Continue risk communication Characterization environmental sampling and analysis Initial risk assessment Clearance goals	Decontamination strategy Remediation Action Plan Worker health and safety Site preparation Source reduction Waste disposal Decontamination of sites or items Decontamination verification	Clearance environmental sampling and analysis Clearance decision	Renovation Reoccupation decision Long-term environmental and public health monitoring

IBRD Scope

Homeland Security
Science and Technology

BioNet Program

Homeland Security

Dr. Peter Van Voris

September 14, 2004

BioNet – consequence management

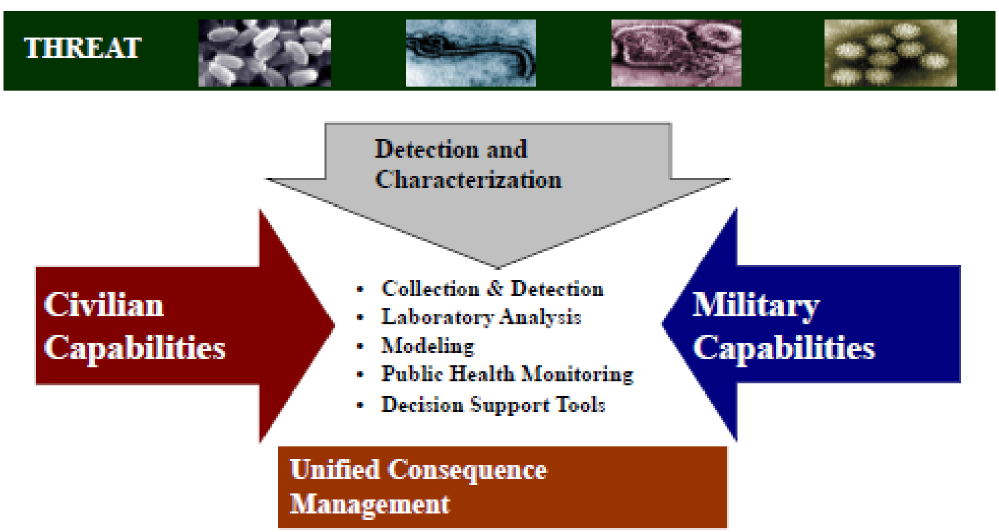
Vision

Effectively manage the consequences of a biological attack

Objectives

- Develop interoperable military and civilian concepts of operation
- Integrate military and civilian capabilities to detect and characterize a biological event
- Provide common situational awareness to ensure timely, effective, and consistent response actions

Program Goal



San Diego stakeholders are engaged

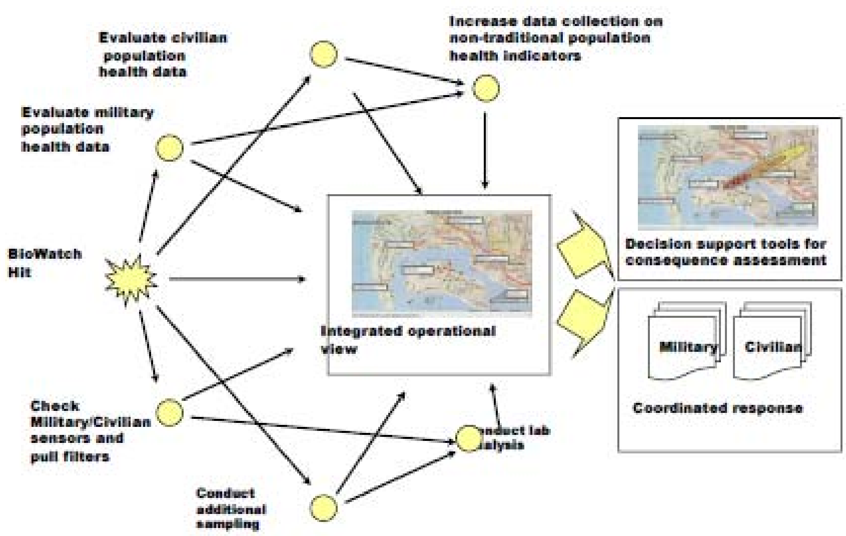
Military

- Navy Region Southwest
  - North Island
  - 3rd Fleet
  - Navy Shipyard
  - Emergency Response Coordinator
  - Operational Medicine (EPMU-05)
- Naval Health Research Center
- Camp Pendleton Marine Corps Base
- Miramar Field
- NORTHCOM

Civilian

- City of San Diego
  - Director of Homeland Security
  - Fire and Life Safety Services
  - Police Department
- County of San Diego
  - Office of Emergency Services
  - Department of Public Health
- US Coast Guard
  - Joint Harbor Operations
- FBI
- San Diego Regional Network for Homeland Security
- California Office of Emergency Services
- California State Department of Public Health

BioNet will integrate these distinct capabilities



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BioNet will yield significant benefits through well defined deliverables

Area	Deliverable	Approach
ConOps	Integrated military/civilian Concepts of Operation for detection and characterization	Build on BioWatch (ICAP) and JSIPP ConOps, evaluate through table-top and command post exercises
Area Monitoring	Enhanced operational test and evaluation environment for area monitoring	Integrate military and civilian area monitoring networks, conduct OT&E of new sensors, model optimum sensor placement
Laboratory	Advanced high-throughput laboratory capabilities, common assays	Conduct side-by-side testing of military and civilian assays, implement high-throughput lab for surge requirements
Health Monitoring	Integrated military and civilian health monitoring system	Integrate de-identified population health data and analysis tools for military and civilian users, optimize use in conjunction with area monitoring and other data types
Information Products	Common operating picture for military and civilian users	Leverage existing incident management hardware and software to generate views for diverse users, provide access to cost effective decision support tools, including reach-back
System Studies	Cost benefit studies of alternative urban biosurveillance architectures	Define key architecture questions and evaluate using real-world (San Diego) and simulated systems
Mobile Detection	Trade-study on fixed vs. mobile detection, including costs	Conduct benchmark study of alternative approaches using nationally-recognized panel

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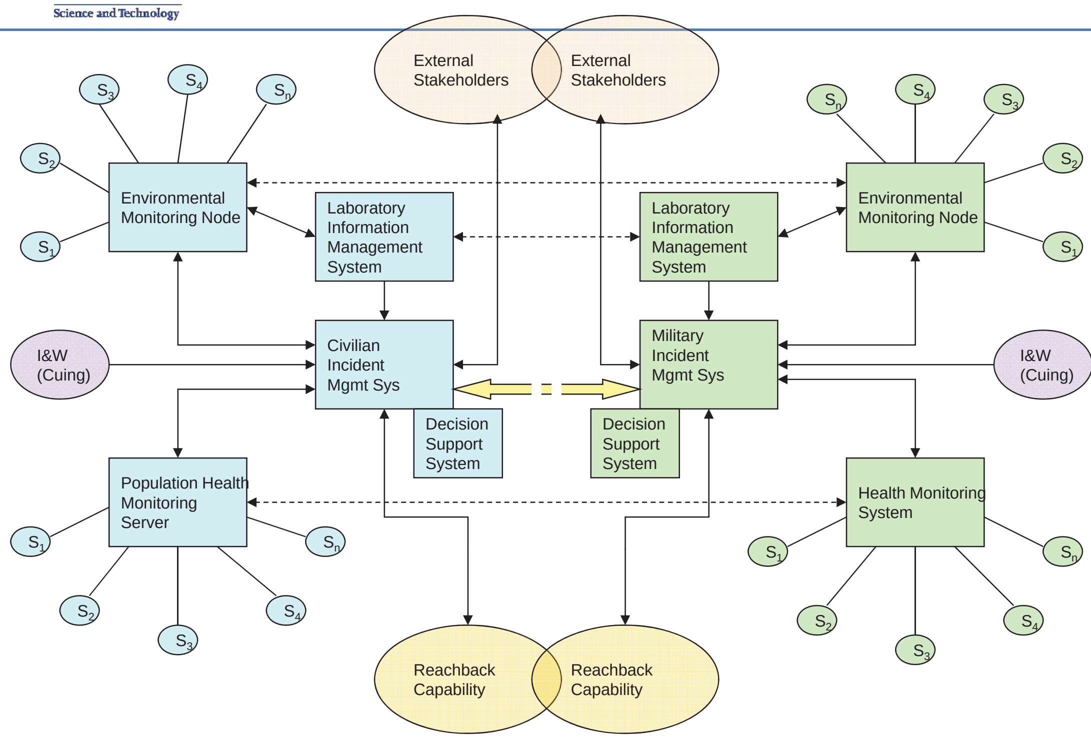
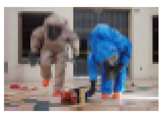
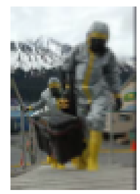
Conceptual Architecture for BioNet



Programmatic Approach

Task	Effort	Capability Target & Objective
1	Front-End System Engineering Study and Gaps Analysis	Body of knowledge for national, state, and local restoration capabilities
2	Wide-Area Recovery Framework	Develop guidance to address civilian & military needs and capabilities for recovery & restoration actions
3	Science and Technology Development	Recovery process methods, procedures, and technology development
4	Workshops, Exercises, and Demonstrations	Coordinate civilian & military community interoperability, and practical application of technology and concepts of operation
5	Transition to Use	





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WARRP Technical Discussion

WARRP Product	Primary Impact Areas	Targeted End User(s) Groups
PLANNING GUIDANCE		
1. Denver UASI All-Hazards Regional Recovery Framework 2. National Urban Area Recovery Plan Guidance 3. Key Response and Recovery Planning Factors for CBR Incidents 4. Critical Infrastructure and Economic Impact Considerations for CBR Incidents	Critical Infrastructure / Key Resources (CIKR), Environmental Health, Public Health, Public Safety, Public Messaging, Housing, Volunteer Organizations	Federal / Regional / State / local emergency managers, planners, decision makers
REPORTS		
1. WARRP System Study and Gaps Analysis	Environmental Remediation, Public Health, Emergency Response/Management	Federal decision makers for future S&T investment strategies
2. Germination-Disinfection for Wide Area Decontamination of *B. anthracis* Spores 3. Evaluation of Fixatives for Wide Area Outdoor Immobilization of *B. anthracis* Spores 4. Waste Screening and Segregation Technologies 5. Expanding Low-technology Decontamination Options 6. Aggressive Air Sampling for *B. anthracis* Spores	Environmental Remediation, Waste Management, CIKR	Civilian / military environmental health responders
TECHNOLOGY SOLUTIONS		
1. Automated Floor Sampling Device for *B. anthracis* 2. Decontamination Strategy and Selection Tool 3. Cs-RDD Wash Aid	Environmental Remediation, Waste Management, CIKR	Civilian / military environmental health responders
4. Enhanced Early Aberration Reporting System (EARS)	Public Health Surveillance	Public Health Community
5. Deployable Mapbook Composer	Situational Awareness, Command/Control	US Secret Service

WARRP Operational Context

Metric: Reduce the time and resources required for recovery following a catastrophic CBR incident

Goal: Recovery in 6 months (Current Estimates 18+ Years prior to IBRD and WARRP)

Operational Context – Wide Area CBR Incident	Existing Capability Gap
PLANNING – Technical Planning Guidance for FEMA, Colorado Department of Emergency Management	
National Preparedness	Insufficient processes to: 2.1 Balance economic & public health concerns 2.2 Provide timely, unified messaging during incident 2.4 Manage and share data in wide area recovery 2.6 Coordinate between federal, state and local stakeholders 2.8 Rapidly reconstitute CIKR lifelines 3.2 Establish regional multi-jurisdictional recovery organizational structure
SAMPLING and DECONTAMINATION– Tools and Technologies Transitions to EPA and DoD	
Environmental Remediation	1.2 Waste minimization policies, processes, and technologies 1.4 Lack of sensitive and/or rapid screening technologies 1.5 Safe procedures for owner-occupant property decontamination 1.6 Effective, scalable options for indoor or outdoor decontamination 2.3 Insufficient knowledge of decontaminant efficacy and break-down products on urban surfaces 2.5 Insufficient accepted sampling methods for urban contaminated materials 2.9 Lack of process-based decontamination verification method to reduce sampling and clearance requirements
PUBLIC HEALTH SURVEILLANCE – Collaborative Information Management System Transition to CDC and DoD	
Public Health Monitoring and Surveillance	2.4 Insufficient methods for data management and sharing in wide-area recovery

Impact Metrics "Why It Matters"

- Efficiency Impacts
  - Significant cost savings ($M-$B) for wide area environmental remediation of CBR
    - More effective, scalable technologies for sampling and decontamination
    - More efficient methodologies for technology selection and operation
    - Improved waste management practices
- Capability Impact
  - Risk reduction for wide area recovery planning
    - Improved technical planning guidance for CBR incidents
    - Improved coordination amongst federal, state, and local stakeholders
  - Increased performance for the rapid recovery of critical infrastructure
    - Improved decision support tools for prioritization and technology selection
    - More effective, scalable technologies for sampling and decontamination

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Impact Metrics “Why It Matters”

- Return on Investment (ROI) Impact – Customer viewpoint
  - Remediation Products (materiel and non-materiel):
    - ROI immediate in case of wide area incident – Tools and Products are required nationwide through FEMA and states by end FY13
    - Otherwise, ROI relatively short through enhanced all hazards planning, coordination, and operations
  - Planning Guidance:
    - ROI relatively short through enhanced all hazards planning, coordination, and operations
  - Public Health Monitoring and Surveillance:
    - ROI relatively short through enhanced computing environment for data management, analysis, and sharing

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Transition Plan

WARRP Project Status

Product	FY11 Feb-Sep	FY12 Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Transition
System Study	Workshops	Analysis & Gaps Consensus			Adjudicate Comments	Study Conclusion								WARRP Stakeholders
Regional Framework	Denver UASI All-Hazards Regional Recovery Framework with CBR Annexes													Aug2012 State of CO DEM
National Guidance	National Urban Area Recovery Plan Guidance								Interagency Review Period			Adjudicate Comments	Final Document	Sep2012 FEMA
Science & Technology	Proposals					S&T Development						Development Demos & Transition		Aug-Dec2012 6x EPA 1x CDC 1x USSS
Transition	Transition Agreement Signings	Products in Development & Transition Remote Messaging Center (RMC) Response & Recovery Knowledge Products (RRKP) Germ-Lysis, Fixatives Reports (G-L, Fixatives) PATH/AWARE (Partial JPMIS – Dec2011)										Transition		RRKP: Jul2012 FEMA RMC: Jan2012 JPMIS G-L, Fixatives Jul2012 EPA
Workshops				Mile High Challenge	Knowledge Enhancement Working Groups (AAR Package)							Capstone		AAR Package: Aug2012 State of CO DEM
Work Groups	Environmental Remediation Operations Work Group (EROWG) Public Health & Medical Services Working Group (PHMWG)													

Scenarios

- Medical Waste Spill of larger proportion
- Source Release - an accident
- Transportation accident of larger proportion
- Terrorist focused on "dirty bomb"
- Terrorist focused on "small device"
- Reactor accident – Chernobyl or Fukushima
- Terrorist focused on a Waste Containment system
  - Storage for spent fuel
  - Hanford Tanks
- Terrorist Delivery of a full yield "Loose Nuke"
- Worst nightmare

Radiological Dispersal Device Debris Response

Waste Segregation Issues

August 14 2012

RDD Debris Response

- RDD Device
  - Stolen Seed Irradiator
  - 2300 Curies Cesium chloride
  - 3,000 pounds prilled ammonium nitrate and 6% fuel oil
  - Pentaerythritol tetranitrate (PETN) booster
  - Stolen detonator cord

RDD Debris Response

- Cesium Complicates Management of Debris
  - Most electropositive element
    - Loses single valence electron
  - Forms electrovalent bonds easily
  - Combines with nearly all inorganic and organic anions
  - Replaces potassium in tissues and cells
  - Radiation destroys rapidly dividing cells

RDD Debris Response

- RDD Device
  - Explosion near Denver Mint
  - Significant debris
  - Damaged structures – no fire
  - Elevated levels of radiation (up to 5 REM) extending several hundred feet from explosion

RDD Debris Response

- Hazard Assessment
  - Residual hazard from contamination of
    - Buildings
    - Debris
    - Turf and trees
    - Vehicles
    - White goods

RDD Debris Response

- Likely Issues of Cesium Contaminated Debris
  - Handling large volume of collected vegetation and building debris and other
  - Waste storage of collected contaminated debris
  - Waste volume reduction
  - Waste treatment of cesium-contaminants
    - Soil
    - Water
    - Other
  - Waste Storage/Disposal

RDD Debris Response

- Expected Remediation Methods
  - Remove ground cover and top few inches soil
  - Wash roofs, walls and attempt to contain water
    - Remove dissolved cesium by zeolite?
  - Remove contaminated debris to temporary debris sites
  - Institutional controls for RDD site
    - Evacuate people (>0.2mRem)
  - Repair of structures/infrastructure damaged by RDD

RDD Debris Response

- Denver's Experience with hazardous debris
  - Asbestos in soil and buildings
    - Parallels to cesium contaminated debris
      - Containment of contaminated material
      - Emphasis on avoiding air-borne dispersal
      - Stringent requirements for transportation and disposal
      - Need for PPE, personal air monitoring and environmental testing

RDD Debris Response

- Denver's Experience with Hazardous Debris (cont)
  - Denver Radium Sites
    - Removal of radium tailings from Denver streets
    - Road base excavated and transported to Grandview, Idaho, Clive, Utah, and Deer Trail, Colorado
    - Approximately five miles of Denver streets remediated
    - Cleanup level (exceeding 2 pCi/g background) of <5 pCi/g Ra-226 surface; and 15 pCi/g Ra-226
    - Institutional controls impossible

RDD Debris Response

- Asbestos Removal Techniques


gac

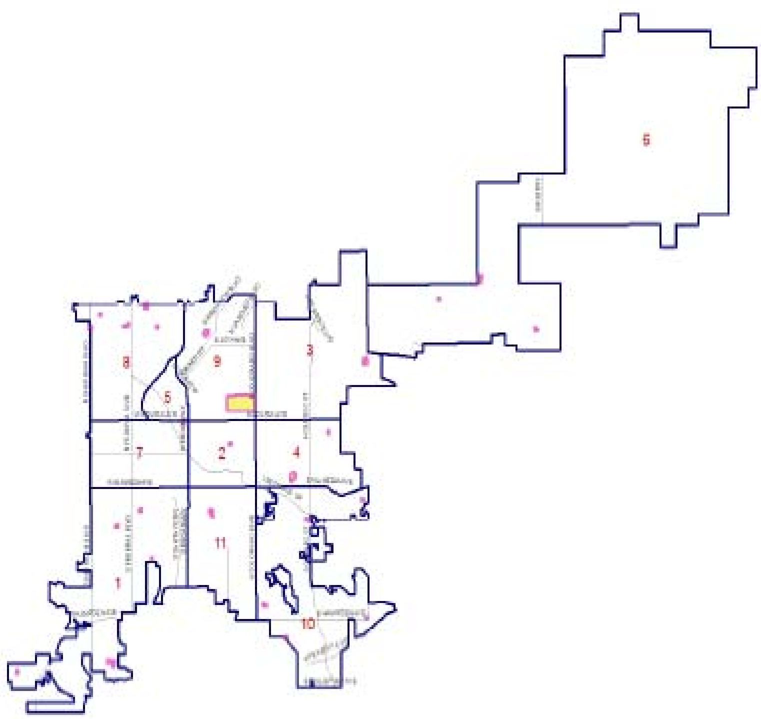
RDD Debris Response

- Radium Streets Legacy
  - Local (Denver) resources
    - 12 B-25 boxes available for transportation of debris
    - 200 Super Sacks available for debris handling
    - DEH rad monitoring capabilities/equipment
      - 2 Ludlum 12 meters
      - 3 Ludlum 17 meters
      - 3 Ludlum 19 meters
      - 2 Ludlum 2241-2 survey meters
      - 24 personal dosimeters
      - 4 high volume air samplers


LIQUOR
Capitol
Liquor Store
BEER

RDD Debris Response

- Denver's Temporary Debris Management Sites
  - 25 locations – typically Denver Parks
  - Envisioned for catastrophic debris generating event
  - Selected for "conventional debris"
  - Limited space available for segregation of waste streams
  - One likely site having paved surface
    - Facilitate post operations cleanup
    - Separated from residential
- Final Disposal at DADS

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Plains Conservation Center
E Hampden Ave
E Quincy Ave

RDD Debris Response

- Site Stabilization and Debris Removal Assumptions
  - Rely on local resources for initial reconnaissance and assessment
  - Use contractors for debris containment and removal under Federal supervision with local input/guidance
  - Limit first responder missions/contractor cleanup missions to radiation dose of no more than 5 rem

RDD Debris Response

- Debris Storage and Disposal- Concerns
  - Denver's Debris Management Plan is silent on RDDs
    - Soluble nature of cesium complicates cleanup
    - Small number of local experienced personnel
    - Cleanup of private property will require/assistance oversight
  - Temporary Storage of Debris
    - Limited capacity for storage and segregation
    - Presence of contaminated debris encumbers Denver facilities
    - Likely would result in long-term environmental contamination
    - Resident opposition for temporary storage of radioactive debris

RDD Response

- Debris Storage and Disposal- Concerns (cont)
  - Temporary Storage of Debris
    - Local activists
    - Environmental justice for residents in likely temporary disposal areas
- Debris Storage and Disposal
  - No local capacity for permanent disposal of contaminated debris
    - Likely mixed wastes (RCRA, petroleum etc) complicating disposal options
    - Agreement with Utah for radioactive waste disposal
    - Expensive to implement and transportation difficult

Waste Segregation Methodologies

US EPA WARRP Workshop

Rick Demmer
Nuclear Materials Characterization
Battelle Energy Alliance
Idaho National Laboratory

Objectives

- Introduce our scenario (i.e. what was Rick thinking about?)
- Introduce the 4 major methods of large scale characterization/remediation
- Basically develop a common ground about the technologies
- Discuss the pros and cons of those methods
- Stimulate discussion about other methods (recategorize new methods if possible)

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Thoughts on RDD Contamination

Based on DHS Scenario 11, Radiological Attack (RDD)

- Cs-137 source (2300 Ci), ANFO yield of about 3000 lbs TNT(?)
- 36 city blocks (20 acres) of contamination ~5-50 uCi/m2
  - EPA's Tests at INL are 42 uCi/m2 Cs-137
  - Converts to about 3.5 to 35 Bq/g (1 inch deep)
  - Target of ~0.01 Bq/g? (30 yr occupational dose)
- Remediation begins more than a month later (and precipitation is likely)

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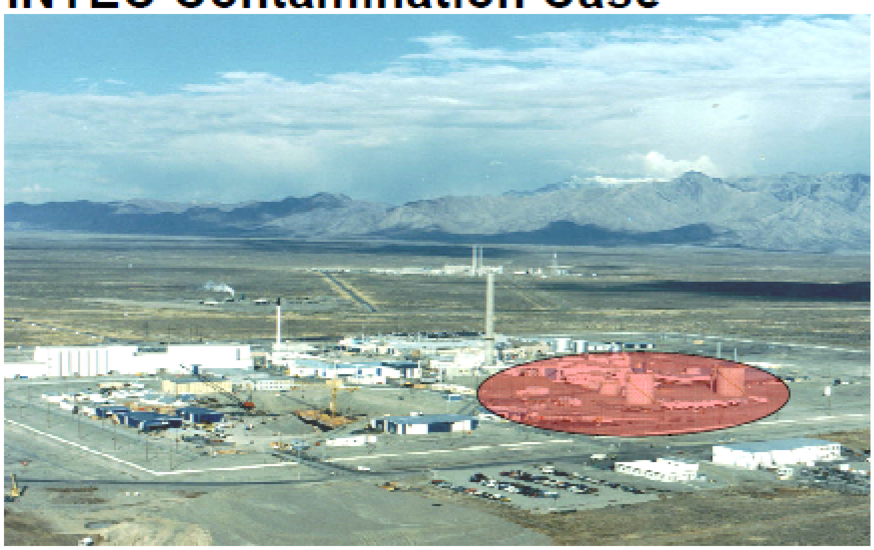
Five Cases Describing Technologies

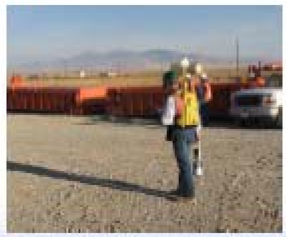
- Idaho Chemical Processing Plant (black flakes)
  - Small Event
- Painesville, OH Radioactive Scrap Recycling
  - Small Area
- Goiania, Brazil
  - A Neighborhood
- Johnson Atoll Fallout Contamination
  - A Small Island
- Chernobyl (countryside), Ukraine
  - Several Countries

INTEC Contamination Case



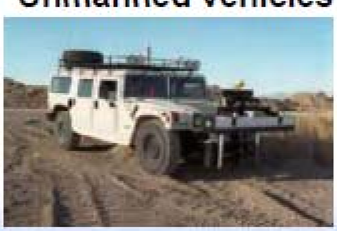
Remediation of INTEC Contamination

- Used Available Eberline 2A instruments
- Carried HEPA vacs from hotspot to hotspot
- Covered about 50 acres in 2 weeks
- Probably 100 people involved
- Several tons of waste



SNL (& INL) Variation of Manual Surveys

- SNL characterization (in-situ) of DU projectiles (lots of fragments)
- Global positioning
- NaI and LaBr Gamma Nuclide ID
- Computer generated mapping (GIS)
- Unmanned vehicles



Large Area Gamma-Spec System (LAGS)

- SNL developed
- Takes survey out of the field (ex-situ)
- 33'X33' X-Y table, 3" deep, 10 yd
- About 30 min. count.

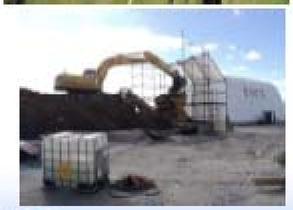
Painesville, OH – Diamond Magnesium

- Recycled radioactive scrap 1951-1953
- Processing areas and uncovered lay-down yards
- 30 Acre site
- 9,400 cu yd of soil removed, perhaps 25,000 yds more because increase in contaminated area.
- Typical contamination about 50 Bq/g, up to 500 Bq/g (U-238)

Painesville, OH – Diamond Magnesium

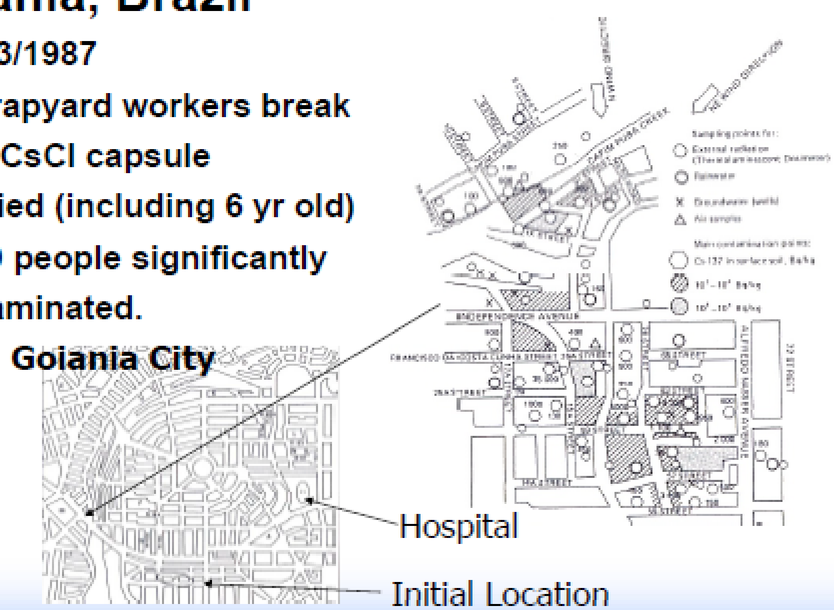
- USACE, 2007 (excavation)
- Segmented Gate System (SGS) for Segregation



Goiania, Brazil

- 9/13/1987
- Scrapyard workers break open CsCl capsule
- 6 died (including 6 yr old)
- 249 people significantly Contaminated.

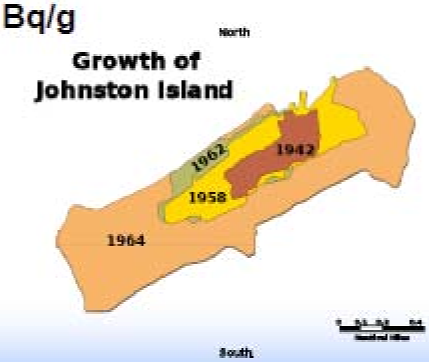


Goiania, Brazil Remediation

- Personal items deconned
- Everything else from neighborhood knocked down, dug up and removed

Johnston Atoll Fallout Contamination

- 24 acre Pu-239 & Am-241 contaminated area
- Contaminated intentional destruction of a nuclear missile (not detonation)
- Contamination up to 5000 Bq/g
- Cleanup target 0.5 Bq/g



Johnston Atoll Fallout Contamination

- Used Segmented Gate System 1990-1998
- Contaminated soil diverted to water wash system (fines continued disposal)
- Overall efficiency of 98%
- SGS + equipment (incl front loader) $1.2M

Chernobyl (countryside), Ukraine

- 4/26/1986
- Released 20 tBq contam.
- Areas in red are ~1 uCi/m2
  - ~1.5 Bq/g (Cs-137, Propagated over 1")

Chernobyl (countryside), Ukraine

- Typical remediation is either “triple” dig, or plow

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Chernobyl Typical Technologies

Technique	Effectiveness, % removed	Age of contamination
Low Impact		
Grass Cutting	32 (wet deposition)	recent
Firehosing of buildings	0 - walls, 30 - roofs	recent
Firehosing of buildings	0 - walls, 25 - roofs	old
Firehosing of roads	0	old
Sweeping roads	20	recent
Ammonium nitrate treatment of buildings	15 - walls, 20 - roofs	recent and old
Medium Impact		
Sandblasting buildings	40	
Firehosing of roads	45 (wet deposition)	
Grass cutting	65 (dry deposition)	
Vacuum-sweeping roads	50	
High Impact		
Washing, vacuuming indoor surfaces	80	
Soil removal to 10 cm	80	
Road planning	100	
Firehosing of roads	95 (dry deposition)	
Sandblasting buildings	100	
Roof replacement	100	
Plowing soil to 30 cm	73	up to 1 year

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The Technologies

Alternative	Cost	Safety	Effectiveness	Throughput	
Manual Survey/Vacuum	$200K	Moderate	Moderate	tons/wk	
Automated Survey	$500K	Moderate	Moderate	10-100 tons/wk	
LAGS	$300K	Moderate	Good	10 tons/day	
SGS	$1,000K	High	Good	up to 500 ton/day	
Dig/Plow	$?	Low	Moderate	tons/day	
Baseline Dig/Haul	$1,000K	High	Good	1000 ton/day	
Soil Washing	$300K	High	Good	20 ton/day	

Costs/Savings Add Up With SGS/CVL

- **Conventional Disposal Costs (Dig and Haul):**
  - Excavation/Screening = $100/yd^3$
  - Transportation = $300/yd^3$
  - Stabilization/Solidification = $200/yd^3$
  - Disposal (Envirocare) = $225/yd^3$
  - Total Unit Cost = $825/yd^3$
  - **Total Cost/100K yd^3 = $82.5M**
- **Disposal Costs using SGS/CVL:**
  - Excavation/Screening: $100/yd^3$
    Applied to 100% of volume: $100x100,000 = $10M
  - Soil Processing via SGS: $55/yd^3$*
    Applied to 100% of volume: $55x100,000 = $5.5M
  - Wet Chemistry: $250/yd^3$
    Applied to 20% of volume: $250x20,000 = $5M
  - Disposal (Envirocare + Transport): $225/yd^3$
    Applied to 4% of volume: $225x4,000 = $1M
  - **Total Cost/100K yd^3 = $21.5M**
- **Potential Cost Savings for 100,000 yd^3 soil exceeds $60M**

* Based ThermoNucleon's quote of $2.2M for 40,000 cu yd. $2.2M/40,000 = $55.

Remediation of Uranium-contaminated Soil Using SGS and CVL Techniques: Cost Effectiveness Study

Mark Cummings, Steven Booth, LANL, LA-UR-96-XYZ

UMTRA Remediation

- Radioactive Uranium ore tailings used in many areas
- 8 Uranium Mill Tailing sites excavated and removed to off-site disposal cells
- 1 (Melba, Co) excavated and used on-site cell
- >4000 properties were remediated
- $75M initial

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A Word From Our Sponsors

- BMI/INL have a terrific basis for testing technologies
  - Urban RDD Decon (TTEP)
    - EPA, DHS, Environment Canada, etc
  - IND fallout testing
  - BOTE (biological decon)
- INL is developing a depth profile system (lacking funds, looking for support)
  - Uses highly collimated gamma detectors/ modeling

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RDD Soil Cleanup Criteria

US EPA WARRP Workshop, August 14-15, 2012

Rick Demmer
Nuclear Materials Characterization
Battelle Energy Alliance
Idaho National Laboratory

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What are Criteria About?

- Everything we do involves identifying and weighing criteria
  - Taking a new job
    - Is salary the most important thing, location, schools, church?
  - Buying a new car
    - Fuel mileage, acceleration, color?
- Engineering analyses were new to this Analytical Chemist until 1991.
  - I've come to know and love(?) them

Impacts on Criteria

- Type of contaminant (radionuclide, chemical nature and physical form)
- Type of substrate (which building material and configuration)
- Weather conditions
- Desired endpoint levels

Freezing?

General About Criteria

- Criteria can be subjective or objective
  - We can have some discussion
- Gut checks are OK, but need to be based on a criteria

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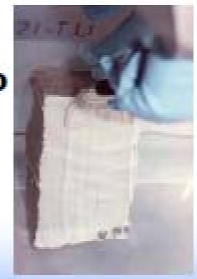
Criteria for Underwater Coatings

- Easy to apply
- Adhere well to the four surfaces of interest
- Can not change or have a negative impact on water chemistry or clarity
- Can not be hazardous in final applied form
- Proven in other underwater applications.
- High pigment or high cross-link density to prevent radiation damage



Wash Water Minimization Criteria

18.1 Functions

Neutralize hazards
Maximize byproduct removal
Minimize waste
Minimize risk
Demonstrate no metal contamination
Remove reactivity
Locate remaining sodium
Define waste streams
Manage expectations with regulator
Determine final reactor end-state (negotiations with DOE)
Passivate the primary tank after cleaning

18.2 Criteria "Wants"

Minimize radiation dose
Minimize hazards
Minimize waste volume
Minimize cost
Regulatory acceptance
Minimize impacts to future D&D. (Short-term activities or RCRA closure activities don't impact future D&D success.)
Technical maturity
Ease of demonstrating RCRA clean
Minimize risk

Wash Water Minimization Criteria

Alternative	Cost	Schedule	Dose	Effectiveness	Future Impact
Weighting of Criteria	26	11.5	31	19	12.5
Optimized (OBA)	24	24	24	25	24
High Temp Steam	23	22	22	21	21
Grout	19	21	21	16	16
Partial Fill and Steam	17	16	16	15	15
No Action	18	18	18	10	10
Baseline	15	15	11	17	17

- Scored 1-25 for each criteria
- Multiplied by weight

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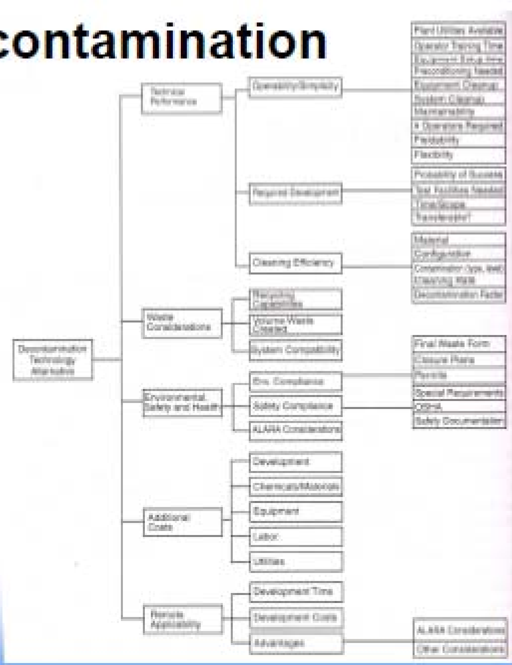
Criteria for Decontamination

Criteria Eye Chart



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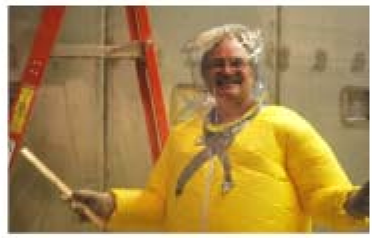
Criteria for Decontamination

- Main Criteria
  - Performance
  - Waste Considerations
  - Environmental/Safety/Health
  - Costs
  - Remote usefulness



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Drilling Down on Performance Criteria - 1

- Performance
  - Operability/Simplicity
    - Utilities availability
    - Training requirements
    - Setup time
    - Preconditioning
    - Cleanup time
    - Maintenance requirements
    - Labor required(#)
    - Flexibility

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Drilling Down on Performance Criteria - 2

- Performance
  - Development Necessary
    - Success Probability
    - Necessary Test Facilities
    - Times Required
    - Ability to Patent/License

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Drilling Down on Performance Criteria - 3

- Performance
  - Efficiency
    - Rate
    - Effectiveness (Df, or percent removal)
    - Versatility (high levels/low levels, different media)

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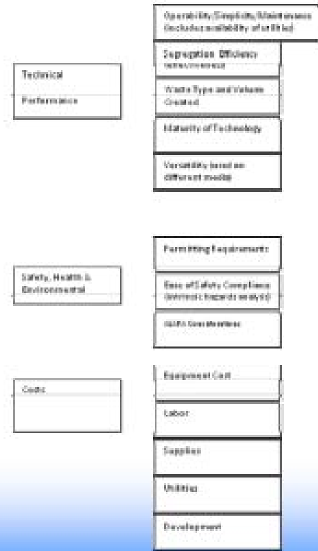
Suggested Criteria for RDD Cleanup



RDD Cleanup Criteria - 1

- Technical Performance
  - Operability/Simplicity/Maintenance (L)
  - Separation Efficiency (H)
  - Waste Type and Secondary Volume (WAC-H, L)
  - Maturity
  - Versatility for Different Media (H)

RDD Cleanup Criteria - 2

- Safety/Health/Environmental
  - Permitting Requirements (L)
  - Intrinsic Safety Analysis (L)
    - PPE vs Engineered controls
  - ALARA Considerations (L)
    - Reduced dose/exposure

RDD Cleanup Criteria - 3

- Costs
  - Equipment/Capital Costs (L)
  - Labor (L)
  - Supplies (L)
  - Utilities (L)
  - Development/Modification (maturity for use) (L)

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RDD Cleanup Criteria – 4 simplified

- Cost
- Throughput
- Expected removal
- Overall hazard mitigation

Better Slice and Dice

Alternative	Safety, Health & Environmental	Time to Implement	Technical Performance	Availability	Costs
	28	26	21	15	10
In-situ remediation					
Manual Survey/vacuum					
Automated Survey/vacuum					
LAGS/vacuum					
Survey/Dig(plow)					

Alternative	Safety, Health & Environmental	Time to Implement	Technical Performance	Availability	Costs
	28	26	21	15	10
ex-situ removal					
Lawn mowing					
Parking lot washer (HEPA)					
Sod cutter					
Scarifier					
Large scale dig and haul					

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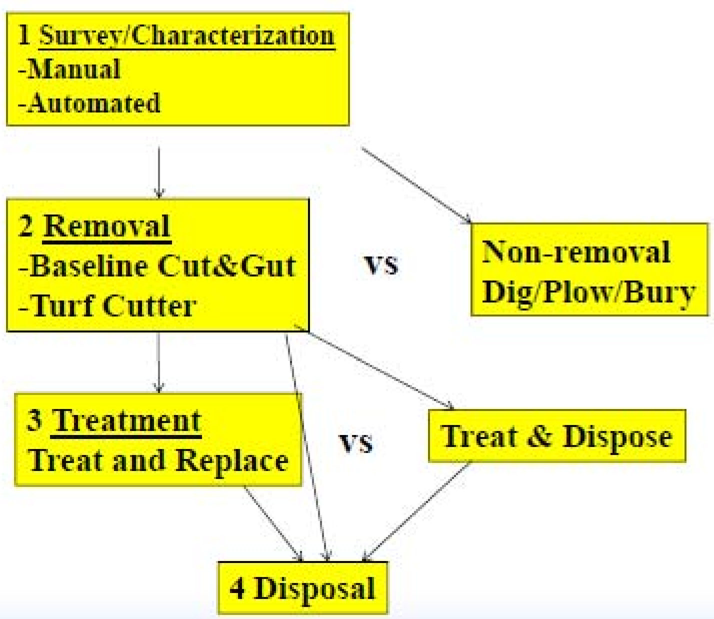

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How to perform weighting

- EPA Weighted Sum Method
- Used in waste min evaluation
- Uses Low/Medium/High
  - Low – little impact on effectiveness, difficult to use, high cost
  - Medium – moderate impact on effectiveness, moderate difficulty, medium cost
  - High – high impact, little difficulty, low cost

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How to perform weighting

- Maximum score of 30 (highly desirable impact)
- H – 30, M – 20, L – 10
- We will use different colored dots that Rachel will hand out.
- Scores will be normalize to 100% for each “criteria set”

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Standard Operational Guideline and Discussion of Path Forward

Rachel Sell, Battelle

Waste Screening and Waste Minimization Methodologies Project

SME Meeting August 14 – 15, 2012

Standard Operational Guideline (SOG)

- Describes the use of the selected waste screening technologies, techniques, and regulations to facilitate waste minimization activities to rapidly screen and segregate radiologically-contaminated waste and debris that is moved from the hot zone of an RDD incident into a waste staging area.
  - Resulting SOG will be included in WARRP planning documentation
- Goal is to give guidance, without being too prescriptive
- Have examples (1) Missouri DA Carcass Disposal and (2) Delaware/Contagious Disease Containment Measures Plan

SOG – Preliminary Content Areas

- Envisioned Content/Outline
  - Purpose (to provide guidelines)
  - Planning Assumptions (for an RDD event)
  - Agencies Roles and Responsibilities/Direction and Control
  - Health and Safety
  - Training
  - Staging
  - Equipment to be used
  - Disposal
  - Communication
  - Quality Assurance/Quality Control
  - Public Information
  - Mental Health Services

Discussion of Path Forward

Task	FY12				
	August		September		October
Literature Review Task 1	Preliminary list of packaging, segregation, and screening technologies directed at radiologically contaminated materials, particularly soils Tues, August 14		Annotated spreadsheet with literature review results (September 14)		
SME Meeting Task 2	Preliminary List of criteria to consider for technologies Tues, August 14	Draft SME Meeting Report – Submitted to EPA within 2 weeks after SME meeting	Revised SME Meeting Report - within 2 weeks after receipt of SME comments		Final SME Meeting Report - within 6 weeks after receipt of EPA comments
SOG Task 3			Draft SOG – Submitted to EPA within mid to end of September . Distribute to SME participants.		SOG in Review [Final SOG (beyond October date) – Review will occur within program offices . Battelle – will finalize SOG within 30 days of receipt of EPA review comments.]